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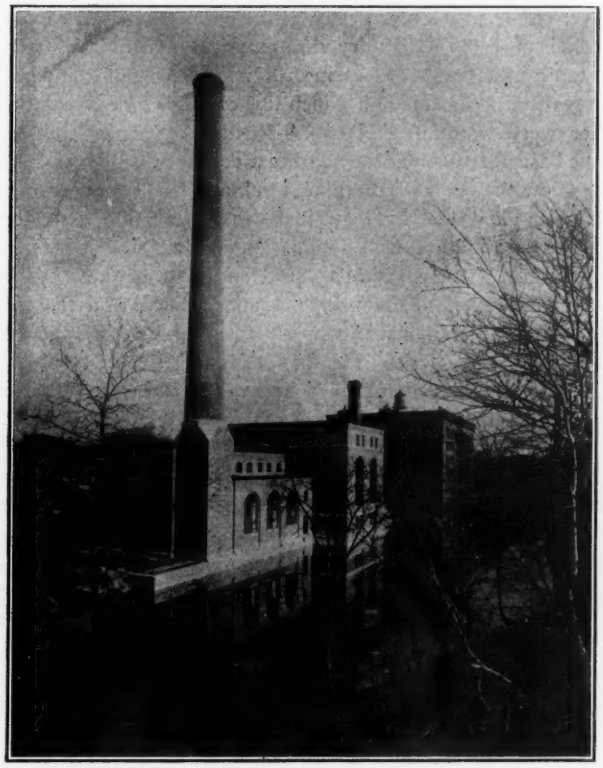
CENTRAL POWER STATION OF A CHOCOLATE FACTORY

Description of the Engine and Boiler Rooms in the Plant of the Walter Baker Co,, Ltd., Dorchester, Mass.

The establishment of the plant of the Walter Baker Company, Ltd., at Dorchester, Mass., a suburb of Boston, embraces a number of mills engaged in the manufacture of chocolate and cocoa. They are located about six miles from the centre of Boston, and embrace plants on opposite corners of the street and the stream, known as the Baker mill, the Webb mill, the Pierce mill, and others. These mills are all large plants in themselves, which have, until recently, been operated by independent steam plants. In each case the engines were pairs of horizontal simple-condensing and non-condensing engines, supplied with steam by horizontal return tubular boilers. Instead, therefore, of having a number of small engine and boiler rooms for each new addition of the plant, it was decided to build an extensive new power station, so that all the mills can be operated as a single unit, by means of which a maximum of economy and reliability might be attained.



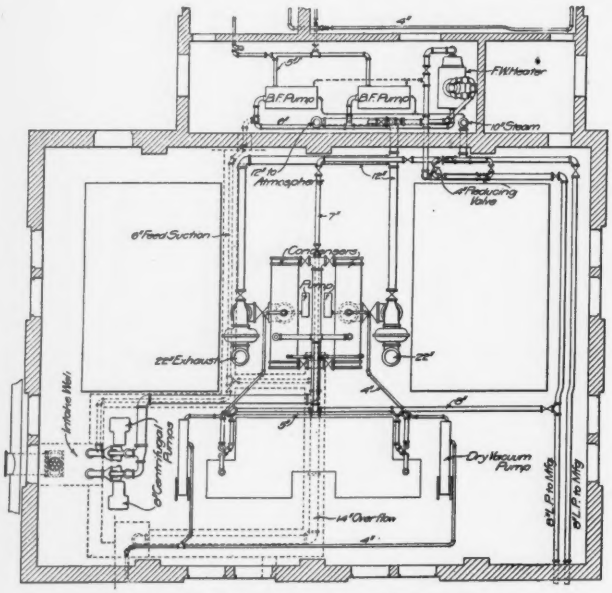
Exterior of the Walter Baker Central Power Plant, Dorchester, Mass.

The new power plant has been located apart from the mills, so as not to interfere with future extensions and additions to the mills, and so that the latter will not be dependent upon power considerations. The power station is situated on the northerly bank of the Neponset River, upstream from the mills, where the stream is several hundred feet in width, and an ample supply of circulating water is available. The river water is of such quality that it is used for feed to the boilers as well as condensing. Convenient rail connections were also available at this point for receipt of fuel and handling of machinery.

The plant is laid out on the cross-boiler-room principle, with a 60 x 80-foot main engine room and a 57 x 96-foot boiler house, extending at right angles from one end. It is constructed of brick on concrete foundations throughout, and has a wooden roof supported on steel truses. The architectural treatment of the exterior is simple, yet productive of pleasing results, a feature of which is the liberal provision of windows for interior lighting. The roofs are covered with tarred paper and gravel, and are nearly flat, draining to the outside with inside gutters. The interior is finished with common red brick painted with cold water paint in the boiler room, while in the engine room the finish is red pressed brick, with limestone trimmings, by means of which an attractive interior has been secured. In the latter room the roof planking is concealed by sheathing of matched North Carolina pine. For the handling of machinery a 10-ton hand-operated traveling crane of 59-foot span covers the engine room, traveling on 20-inch I-beam runways, which are supported upon ornamental pilasters in the wall construction at frequent intervals.

The plan has been designed for an ultimate capacity of 2800 horse-power in boilers, and 1750 kilowatts in electrical generating machinery. The steam generating capacity consists of vertical fire-tube boilers in 200 horse-power units, for which space has been provided in the boiler room for two rows of seven on either side, facing a central firing floor. Of these,

five are installed on each side at the end of the boiler room nearest the engine room. Special features of the steam plant are the use of the vertical fire-tube boilers, hot gas reheaters for reheating the intermediate stage steam from the compound engines and flue gas economizers. The hot gas reheaters are located on an elevated platform at the engine-room end of the boiler room, and the economizer in a 17 x 86-foot annex to the southerly side of the boiler room. The boiler room proper is 40 x 96 feet in size, and has a clear headroom of 36 feet under roof trusses, there being no basement, although there is, under the elevated platform carrying the hot gas reheaters, a 13 x 42-foot space, with 12½ feet clear headroom, in which are located the boiler feed pumps and heater. The main engine room, which is 60 x 80 feet in size, has a headroom under the roof trusses of 40 feet to provide for vertical engines and the traveling crane above, and a basement with 10 feet minimum headroom, acommodating condensing equipment and piping.



Plan of Engine Room and Basement

The engine room contains two large vertical compound engines, two horizontal engines, two turbines and a motor-generator set. The two large units are Allis-Chalmers cross-compound vertical engines, which have 22-inch and 48-inch cylinders, with 48-inch stroke, and which operate at 120 revolutions per minute. They are both direct-connected to 750-kilowatt alternating-current generators, which are mounted alongside of the 15-foot flywheels on the engine shafts. The two smaller generating units consist of simple horizontal 18-inch x 26-inch Watertown engines, direct connected to 125-kilowatt alternators, and operating at 177 revolutions per minute. The exciter units consist of two De Laval steam turbine generator sets of 50-kilowatt capacity each, which, together with a motor generator set equal capacity, are utilized for excitation purposes. The large units are supplied with steam by 8-inch connectors from the boiler room main, while the small horizontal units have 5-inch connections and the turbine 3-inch connections from the basement steam main. The larger units exhaust to the condensing units in the basement, and the small engines to the low-pressure mains in the basement.

A feature of the engine installation is the use of reheaters for the compound engines, which are supplied with heat by the hot gases passing from the boilers to the stack. These reheaters consist of large cylindrical receivers, each fitted with a large number of 6-inch boiler tubes, through which the hot gases are passed. They are located on a concrete platform in the boiler room, elevated 13 feet above the floor, to facilitate connections to the flues and economizer. The smoke connections are led to both reheaters in multiple, while the steam connections are separate, one reheater serving for either engine. The latter connections consist of 10-inch lines from the exhaust side of the high-pressure cylinders, and 18-inch return lines from the reheaters to the admission side of the low-pressure cylinders, the steam being superheated about 30 degrees Fahrenheit in passing through the reheaters under ordinary conditions. The oiling of the compound engines is accomplished by gravity from an elevated tank, the oil after passing the engines flowing by gravity to a filter in the basement, from which it is returned to the elevated tank again by a small duplex pump.

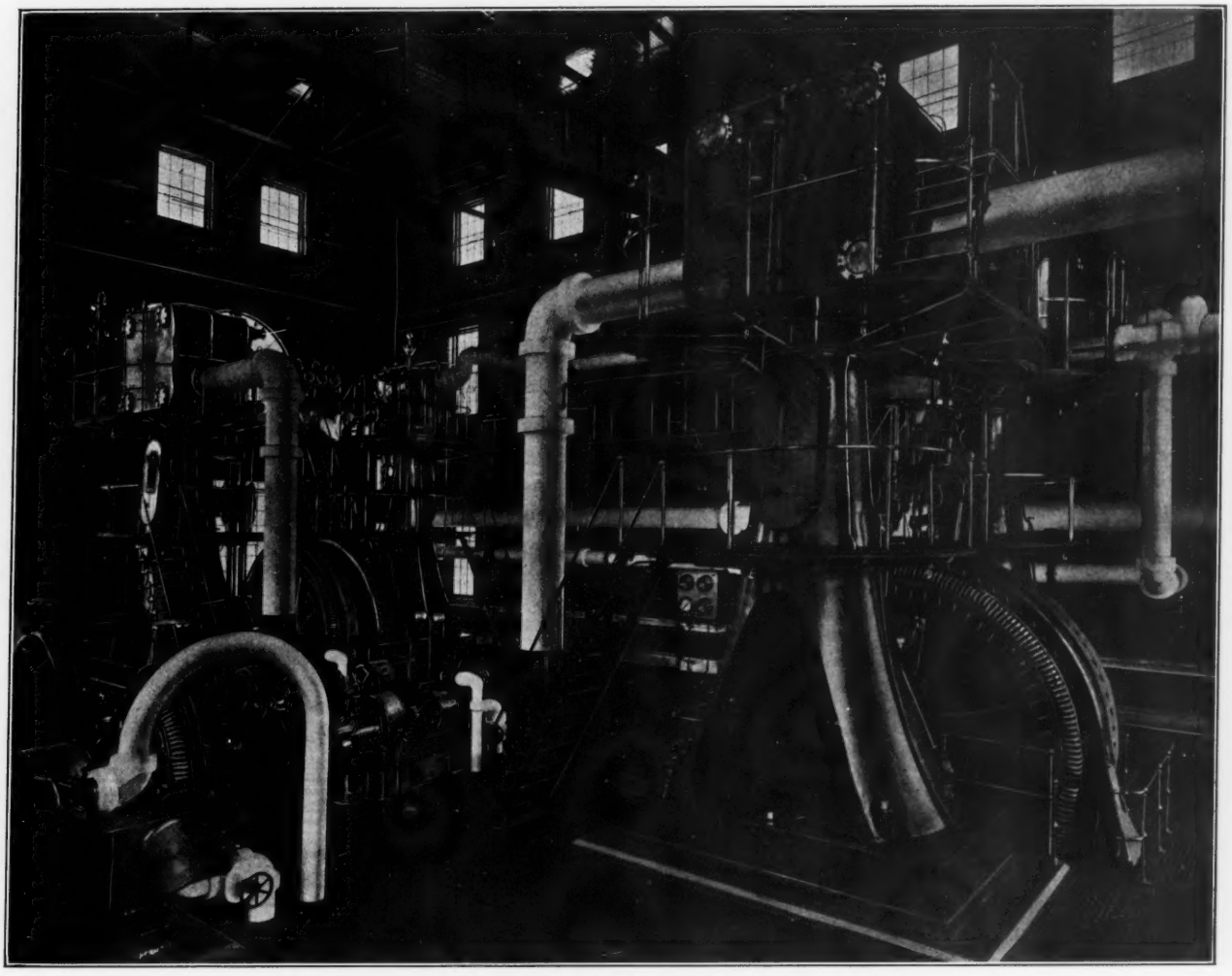
The condensing equipment consists of two Alberger surface condensers, one serving for each of the compound engine units, to which circulating water is supplied from the Neponset River by two electrically-driven Alberger centrifugal pumps. The condensers have separate 5¼ x 4¾ x 5-inch duplex condensation pumps located in a pit under the hot wells, which deliver to the feed-water heater in the pump room. Each condenser is operated with a dry vacuum pump, which draws from the top of the condenser casing through 4-inch lines and discharges through a common 4-inch line ending in the circulation water overflow outlets. The 6 x 8-foot intake well is depressed in the basement floor at the southeast corner next the river, 16 feet below the engine-room floor level, and has a connection to the river alongside by a 36-inch cast-iron pipe extending through the building-wall foundation at that side. This intake pipe is provided with a valve, so that the water can be shut off and the well pumped out and cleaned, and the well has two sets of removable copper screens on the inner end of the inlet pipe.

The electrical generators deliver three-phase, alternating current at a potential of 600 volts, at which voltage current is transmitted directly to the mills for power and lighting purposes. The power feeders and the machines are controlled from a blue Vermont marble switchboard 60 ft. in length, which contains panels for the generators and feeders, and totalizing instrument panels. All circuits to the different mills have recording meters for measurement of the power supply to each department separately. The mills are operated entirely by induction motors, of which there are about 100 installed, ranging from 1 to 75 horse-power and arranged for both individual and group driving. The lighting is done on the two-wire system at 110 volts, the voltage being reduced from the power feeder lines by transformers at each mill. The power feeders are carried to the mills through a steel bridge to the Baker mill, from which they pass over a bridge across the river to the Webb mill and through a subway some 200 feet in length under Washington Street to the Pierce and other mills.

The boilers have 8-foot shells standing 26½ feet above the floor and have 308 2¼-inch tubes 15 feet long, which present an effective water heating surface of 2,000 square feet. They

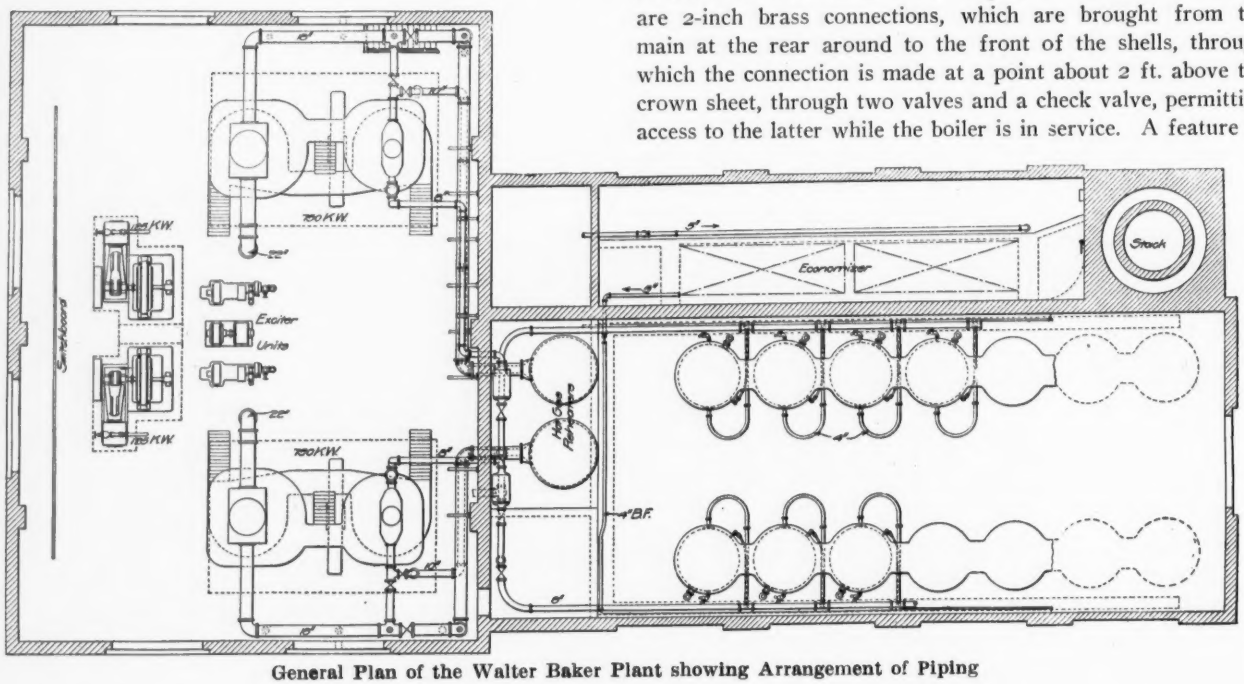
are internally fired, having grates 7 feet 4 inches in diameter with combustion spaces 6 feet above the grate level. They are arranged for hand firing, coal being wheeled into the boiler room, which, together with the handling of ashes, is greatly facilitated by the use of a central firing floor with rows of boilers on either side. The products of combustion are removed by a 200-foot brick stack of 8-foot interior diameter, which is located at the rear corner of the boiler house and is connected to the boiler smoke boxes by an overhead flue. The flue is of $\frac{1}{8}$-inch steel, suspended from the steel roof trusses, and ranges in size from 6 x 4 ft. at one end of the boiler room to 6 x 8 ft. at the other, where connection is made to the hot gas reheaters and thence to an economizer in the side addition to the boiler house, which extends back to the stack at the rear end. The connections from the flue to the boilers are 20 x 60-in. ducts which connect with the side of the smoke boxes so that the entire top of the latter is left free for removal for access to to boiler tubes. From the large end of the flue two 40 x 80-inch connections are taken to the tops of the hot gas reheaters, from the bottom of which ducts of similar cross-section lead across into the annex building, to connect with the economizer.. Both of the reheaters have 40 x 80-inch dampered by-passes and the economizer has a by-pass 8 ft. square formed under the concrete platform on which it is supported. The damper regulator is located at the point of connection of the economizer flue to the stack. The fuel supply for the plant will be stored in the yard outside the plant from which it will be brought to the boiler room by a telpherage system.

The boiler feeding equipment consists of two duplex outside end packed feed pumps, a Cochrane feed-water heater and purifier and a Sturtevant economizer, all of which have been installed of sufficient capacity provided for the total projected boiler plant of 14 boilers. The pump and the heater are located in the space underneath the elevated platform carrying the hot gas reheaters, and the economizer in the side addition to the boiler room, in which it is mounted on a concrete platform 8 ft. above the floor level and is 44 ft. in length. The feed pump suction connections are so arranged that the pumps will ordinarily draw through 6-inch suctions from the feed-water heater into which the condensation from the surface condensers is delivered by condensation pumps in the engine room basement. Make-up water is added from the city water system, from the circulating water or from the pond directly.

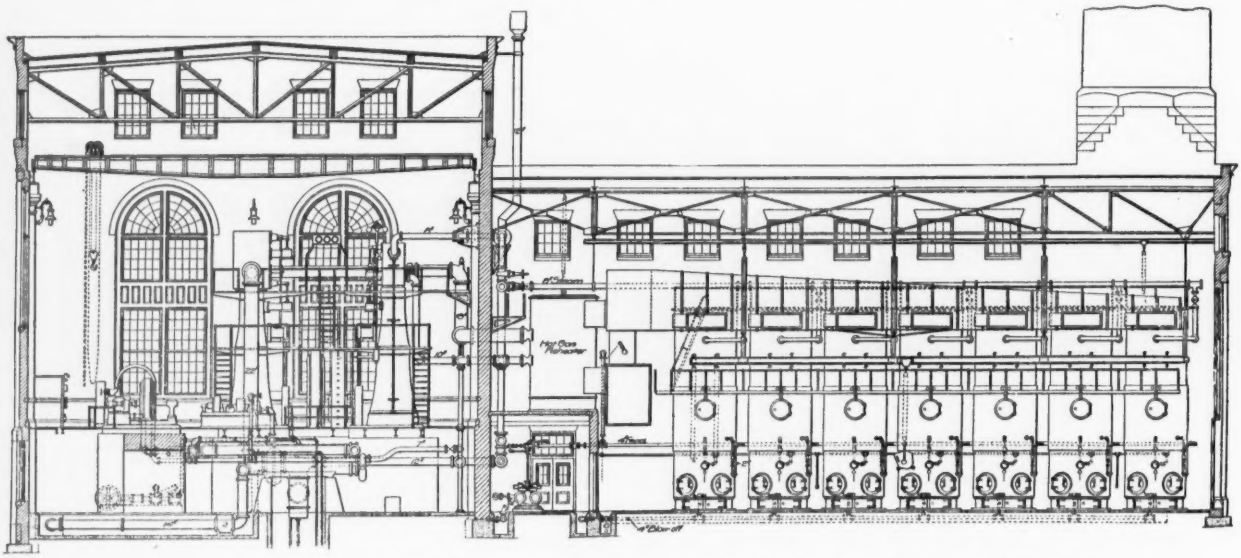


Interior of Engine Room, Walter Baker Co., Ltd., Dorchester, Mass.

The feed heater is supplied with steam from the exhaust delivery line from the small generating units and auxiliary steam-using machinery in the plant to which it is connected inductively, low-pressure steam being used in large quantities in the various mills for manufacturing purposes. The atmospheric relief connection from this low-pressure line is made through the feed heater, a 6-inch relief line with two Schutte back-pressure valves connected in multiple being extended from the top to the 12-inch atmospheric exhaust riser, which serves the main engines of the plant. Watts reducing valves admit live steam to the low-pressure system as needed to maintain the pressure. The feed pumps deliver through a 5-inch line which extends to the economizer, with, of course, a by-pass connection direct to the boilers. The latter is a ring main of 4-inch brass pipe, which is laid out to encircle the boiler room, although at present it has been extended only so far as the boiler units now in place. The boiler branches are 2-inch brass connections, which are brought from the main at the rear around to the front of the shells, through which the connection is made at a point about 2 ft. above the crown sheet, through two valves and a check valve, permitting access to the latter while the boiler is in service. A feature of the water connections to the boilers is a cold water main paralleling the ring feed main, from which a connection is made to each boiler for purposes of washing out and for filling up after washing, consisting of a 2-inch branch with stop and check valves; it is supplied directly from the city water main. Feed pumps have an emergency delivery connection to this main to permit feeding to the boilers in this way if anything should happen to the regular feed main. The



General Plan of the Walter Baker Plant showing Arrangement of Piping



Longitudinal Section of the Central Power Station of the Walter Baker & Co., Ltd., Dorchester, Mass.

boiler blow-off system consists of a 4-inch cast-iron blow-off main located in a trench at the rear of either row of boilers, which connect with a cross line of similar size at the forward end of the room, leading to discharge into the river alongside. The boilers have 2½-inch blow-off connections into the main, each consisting of two Morris blow-off valves connected in series. The economizer has a 4-inch blow-off connection which delivers into this line at a point near the side of the building while the feed-water heater has an independent 4-inch blow-off line which is carried in the same trench to the point of discharge.

The high pressure steam piping system consists of an 8-inch ring main in the boiler room, with 4-inch supply main connections from each boiler, and has delivery connections to the main engines in the engine room, to the auxiliary machinery in the basement, and to the high-pressure delivery lines to the mills. The ring main is supported by hangers from the roof trusses at a level considerably above the tops of the boilers, the boiler branches consisting of double long radius bends.

The two large vertical engines are supplied independently by 8-inch connections which are carried up at the division wall end of the boiler room to 30-in. x 42-in. receiver separators extending thence through the walls to the throttle valves. For the supply of the small horizontal engines, the auxiliary machinery and the high-pressure line to the mills, a 10-inch line extends down into the engine room basement, from which an 8-inch branch extends to the mills and a 7-inch line to the auxiliary machinery, the horizontal engines, the dry air pumps, the condensation pumps and the boiler feed pumps.

The exhaust piping for the large engines consists of direct 22-inch connections from the low-pressure cylinders which go through the floor to independent surface condenser units in the basement. In each exhaust pipe there is an automatic relief valve, delivering to 12-inch lines to a common atmospheric riser and exhaust head above the boiler room roof. In each of the 22-inch exhaust connections from the engines, there is inserted close to the condenser, a 24-inch Cochrane oil separator, for the purpose of freeing the exhaust steam from lubricating oil entrained from the engine cylinders and thus preventing contamination of the boiler feed.

The auxiliary exhaust system starts in an 8-inch connection to the intermediate stages of the large vertical compound engine units, at points where the exhaust pipe from the high-presure cylinders enters the hot gas reheaters. From here the line drops into the pump room where it is joined by the 3-inch exhaust from the feed pumps and enters the open feed-water heater through an oil separator. The exhaust piping then extends into the engine room basement where it is joined by an 8-inch main serving the horizontal generator engines, the exciter engines and the condensation pumps. It then continues as an 8-inch line to the mill building for the low-pressure steam supply. There is a reserve connection to this low-pressure main from the live steam header in the engine room basement, consisting of a 4-inch Watts reducing valve with by-pass, thus permitting live steam to be added in case of deficiency of the exhaust. The low-pressure supply is ordinarily furnished by the small engine units and the auxiliaries, the connections to the intermediate stages of the compound engines being for the purpose of adding to this supply without the use of live steam and still without sacrificing the advantages of operating the large engines condensing.

This power plant and the new power and lighting equipment of the various mills was designed and constructed by Mr. F. W. Dean, mill engineer and architect, of Boston, Mass.

Methods Used for Making Plate Ice

There are five systems in general use for making manufactured plate ice: the direct expansion plate system, the direct expansion plate system using "still" brine, the brine cell plate system, the brine coil plate system, and the block system.

The direct expansion plate system is the simplest in construction and consists of direct expansion zig-zag coils with one-eighth-inch plates of iron bolted or riveted in place. The thawing off of the face of the ice is accomplished by turning the hot ammonia gas from the machine direct into the tank coils.

The direct expansion plate system with still brine, known as the "Smith" plate, is similar in construction, excepting that the coil is immersed in a brine solution contained in a water and brine-tight cell. Thawing off is accomplished by turning hot gas into the coils.

The brine cell plate system consists of a tightly caulked and riveted cell or tank about 4 inches thick, provided with proper bulkheads or distributing pipes, to give an even distribution of brine throughout the plate. The thawing off of the face of the ice is accomplished by circulating warm brine through the plate.

The brine coil plate system is similar to the direct expansion plate, excepting that brine is circulated through the coil instead of ammonia. Thawing off is accomplished by means of warm brine circulated through the coils.

In the block system the ice is formed directly on the coils, through which either ammonia or brine is circulated. After tempering, the ice is cut off in blocks the full depth of the plate by means of steam cutters, which are guided through the ice close to the coils.

The method of harvesting is similar in all of the foregoing systems, excepting that in use for harvesting black ice. Some use hollow lifting rods and thaw them out with steam, others use solid rods and cut them out when cutting up the ice, and others again use chains which are slipped around the cake when it floats up in the tank.

Cutting up the plate is accomplished by means of steam cutters, power saws and hand plows. In the block system, however, where the ice is cut off the plate in the tank, it only remains to remove the cakes by means of a light crane and hoist and divide them into the required sizes with an ax or bar.

Agitation is now almost universally accomplished by means of air jets located midway between the plates, sometimes in the center, sometimes 3 or 4 feet from one end and sometimes at both ends of the plates.

The failure of a safety-valve is often due to corrosion either of the valve upon its seat or of the guiding spindle in its guides. The safety-valve should, therefore, be frequently lifted by hand, in order to be sure that corrosion has not affected its action. Further precaution is secured by using a valve whose valve and valve seat are made of non-corroding material.

THE PRINCIPLES OF ABSORPTION REFRIGERATION PLANTS

Conditions of Operation and Methods of Construction

By Jos. H. Hart.

The chief difficulty which the manufacturer of absorption refrigerating plants has before him to-day is that of a satisfactory supply of operating engineers to properly manage new installations, and it is with the object of presenting this phase of the situation before the operating engineer that this article is written. The absorption system of refrigeration has undoubtedly had a very checkered career. It was the first practical type of mechanical refrigeration in active operation, and as a natural consequence was originally very inefficient. With the advent of the compressor into the refrigerating field the complete disappearance of the absorption type was considered a foregone conclusion. However, the absorption type has undergone rejuvenation and is to-day not only an active competitor of the compression type but is much superior from an efficiency point of view in many installations, and the result of its history to date has been that it is to-day almost impossible to obtain satisfactory and efficient men for the operation of these machines. The situation is perfectly logical and was to be expected, but the advantage which will result to the individual operative engineer from a thorough realization of these conditions is equally recognizable. To see all this more clearly, the subject will be considered more in detail and the difficulties in finding suitable men thoroughly considered. In order to understand the thing more thoroughly a brief explanation of the absorption type will be more or less necessary. This mere statement is enough to show that the situation in regard to the operation of the absorption type from the operating engineer's point of view is not in a satisfactory shape.

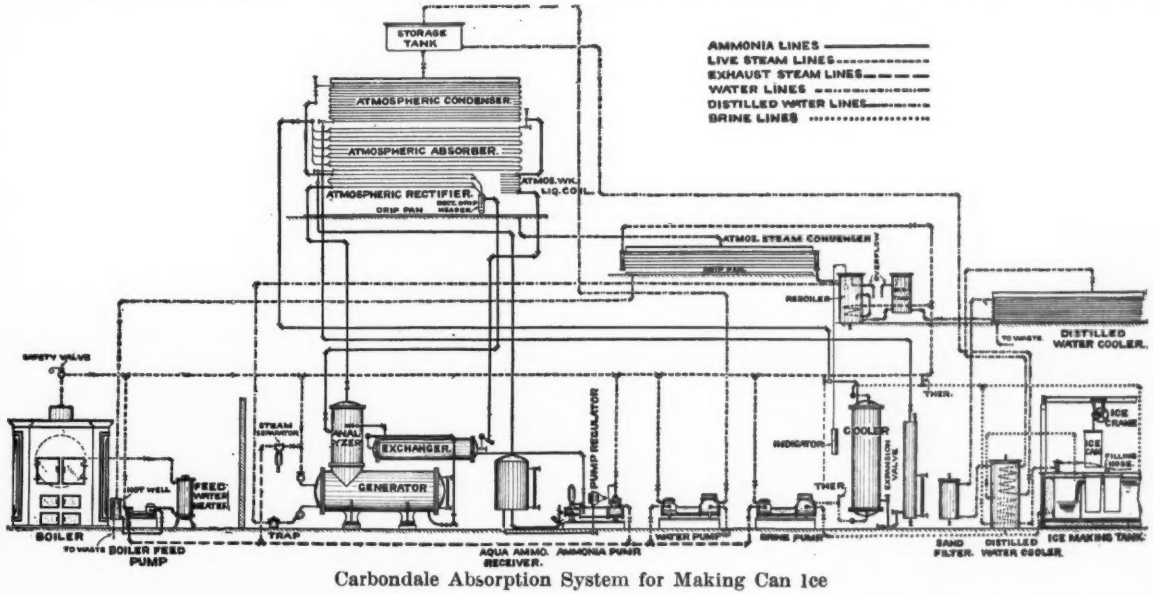
As is well known by a large body of men, but only in a general way, the absorption type produces mechanical refrigeration by utilizing the absorptive power of water for ammonia vapor, together with the loss of this power with rise in temperature, to produce mechanical refrigeration. The majority of operating engineers who have any working knowledge at all of the absorption type acquired this through the operation of some of the earlier very inefficient types which are rapidly changing to-day to modern plants or else gradually disappearing. This training has undoubtedly produced a large body of men who have some working knowledge of the absorption machine under old conditions, and who are thoroughly cognizant of its extreme inefficiency and who as a result are unable, or unwilling, to believe in the high efficiency of the modern type and the comparative complications involved in its operation.

The absorption machine represents an isolated development. It has a separate and distinct process from the ordinary steam and power plant development and, on the other hand, is not sufficiently connected to the various technical and chemical processes to which it is more or less allied. The result has been that scientific progress has passed this by in its general advance, and it has only been within the last decade that real improvements have become possible in this type. The absorption plant, as it exists to-day, consists of a rather large number of distinct units. It consists of the steam boiler and ammonia generator. Then follows the analyzer or rectifier, with the dehydrator or preliminary condenser as the fundamental units involved in the generation of the ammonia gas. After this comes the ordinary ammonia condenser with the pumps required for water supply, followed by the absorber with the ammonia pump to pump the strong, cool liquor back into the generator and the interchanger. In addition to this system of units th utilization of the refrigeration itself must be added in another group. This may consist of a shell cooler for cooling brine or of a set of pipes for traversing a brine tank for ice making. In addition there are the ordinary oil and steam traps, with gauges and thermometers and various pipes for shifting the ammonia charge, and possibly a water tank, with the cooling tower, for the complete circuit of the cooling water. In comparison to a compression plant this system appears complicated, and in fact it is; but complication invariably follows in engineering development in the attempt to gain increased efficiency. This can be readily seen when we consider the modern steam power plants, with double expansion engines, Corliss valves, atmospheric condensers, automatic feed stokers, feed water heaters, injectors, and various types of circulating boilers. Invariably the attempt to increase efficiency in almost any development results in increased complication of operation, and the stationary engineer who would refuse to consider the increased complication of operation in steam units would undoubtedly be regarded as holding an unreasonable position in regard to such development.

However, this does not explain in reality the situation as it exists to-day. Old type, inefficient absorption machines were almost as complicated as the modern developments, and it is more especially necessary for the average engineer to realize the essential points in the development upon which the rise in efficiency has been based. These consist of a number of diverse developments more or less interrelated and of such a character that although each may appear small in its separate effect, in the aggregate they have been sufficient to raise the absorption type from a position in which it could scarcely be regarded as a competitor of the compression type to a point where over 90 per cent. of refrigerating plants of over 200 tons capacity are of this type. In order to understand this, it should be explained that the old absorption system operated almost entirely on a hit or miss principle. Practically nothing was known about the physical properties of ammonia gas in conjunction with water. And it can be readily understood by the average stationary engineer to-day what the situation would be in steam or electrical engineering if practically nothing was known about the behavior of these two physical agents. To illustrate this in the actual working of the absorption type. When a solution of aqua ammonia or of water and ammonia

gas was heated in the generator of the absorption plant, both steam and ammonia gas were evolved. These existed in varying proportion and the utilization of a rather high temperature in the production of this mixture invariably resulted in the production of a large excess of steam. Again, no attempt was made to construct the generator on a design to eliminate this steam production, or at least diminish its amount. To-day in some old-fashioned machines a very large amount of steam is generated, together with the ammonia gas, and carried over into the analyzer and dehydrator. This represents a distinct loss in heat and increase in steam consumption or heat from the boiler, since when the heat leaves the generator it seldom returns. Improvements in this particular unit have been not only from a constructive point of view, but also from an operative one as well. Thus, the modern ammonia generator is constructed to operate on the fractional distillation principle. If a mixture of ammonia gas and water is kept constantly at a comparatively low temperature, only slightly above that of boiling water, the ammonia gas will be evolved with almost no production of steam. When the proportion of ammonia gas in the material diminishes, as it will by this process, the mixture must, in turn, be heated a little hotter for conditions of generation to continue in this form, and there must be a gradual increase in heat as the density of the aqua ammonia increases in its passage through the generator, or rather, as the percentage of ammonia diminishes. This is attained to-day as much by means of a skillful operator as by means of especial design of machinery. He cannot accomplish this result if he does not understand the theory of the process and the object to be attained. The modern ammonia generator is more at the mercy of the operating engineer in regard to maximum obtainable efficiency than it is to any details of design or construction. With a satisfactory man at this point the increase in efficiency that can be obtained at this unit alone is enormous. Again, the modern generator permits of rapid repair work, and is easy of access and simple in control.

Above the generator is placed the analyzer, which in general consists of a number of baffle plates or obstructions to catch and detain and return to the generator as much of the water vapor as is possible. The operation of this analyzer, as can be readily seen, is dependent in turn upon the action of the generator. If large quantities of steam are produced in the latter, the analyzer ceases to work efficiently, as it has been constructed to operate best when the generator is operating under similar conditions. Again, the action of the analyzer is dependent very greatly upon temperature conditions. A too low temperature will result in condensation of the steam rapidly, and this condensed water may, in turn, absorb a large quantity of ammonia gas which, as can be readily seen, is a distinct loss. From the analyzer the ammonia gas, with a certain percentage of water vapor, steam, in it, even under satisfactory operating conditions, enters the dehydrator. This latter in reality is a fore-cooler of the ammonia gas. Its object is to cool the ammonia gas and water vapor sufficiently to permit of almost complete condensation of the water vapor with minimum condensation of ammonia gas. Thus, a possible variation of 5 degrees in the temperature of the condenser water, or a wrong operating speed of the generator itself, is sufficient to cut down the efficiency of this device enormously. When the absorption type is operated efficiently in regard to its units, the dehydrator possesses a very great efficiency and is able to transmit ammonia gas practically 99½ per cent. pure to the ammonia condenser proper. If anything gets out of order, or the capacity falls down, the operating engineer of the old school invariably raises the steam pressure and speeds up the ammonia pump. The result is that he attains the old capacity but at a great loss in efficiency. The ammonia gas goes through the analyzer and dehydrator at relatively great speed and the amount of water vapor carried through is enormous. This in turn condenses and clogs up the condenser and cooling coils and diminishes refrigeration very greatly. The result is that the engineer in turn is apt to speed up the dehydrator; that is, increase the flow of the water over this, or diminish its



Carbondale Absorption System for Making Can Ice

temperature, if possible. This means that the water vapor, which is condensed absorbs in turn a large amount of ammonia gas, it also takes the heat from the ammonia gas, reproduction of the ammonia vapor. It can be readily seen that the generator is merely a heat receptacle, with a large number of leaks for heat loss. In reality the only heat removal from the generator should be in the steam condensation and in the ammonia gas and in radiation losses. When water vapor leaves the generator it takes a portion of the heat. When it condenses and drags back with it ammonia gas,it also takes the heat from the ammonia gas, which was put in it for the production of refrigeration. Thus, the action of the absorption machine presents wide possibilities for an operating engineer to go wrong. Almost any of the symptoms that show as representing inefficient operation, or at least presenting signs that would warrant investigation or repair, can be completely removed or eradicated by the operating engineer without loss in capacity but with a tremendous loss in efficiency of operation. These latter, going off in the cooling water, are not perceptible to the ordinary owner on inspection and the result is that the absorption plant often acquires a bad reputation in regard to efficiency when it is well known that the plant itself possesses an efficiency of a very high type when properly operated.

This design represents all the phases of the absorption system from a comparative point of view. Each and every one of the units permit, in turn, some modification by the operating engineer in their maintenance which may change them from highly efficient mechanisms to extremely inefficient ones. Thus the absorber consists of a chamber or system of pipes for the absorption of the ammonia gas as it comes from the cooling coils by the weak aqua ammonia. Now, aqua ammonia only absorbs the gas when it is cold. Rise in temperature causes it to lose this power. Hence the absorber is traversed by a number of pipes through which cold water is kept flowing. Now, in actual and efficient operation the absorber is very efficient in the performance of this duty. However, slight changes or a lack of knowledge may make it go wrong and very far wrong. Thus, when the gas is absorbed the aqua ammonia becomes hot, and the cold water is used to keep it cold, so that it will absorb to its full absorptive capacity. If the machine is speeded up to increase its capacity rendered necessary by the inefficient operation of some of the other parts, the absorber, in turn, must do more work. The result is that the weak ammonia liquor gets hot rapidly and requires much more cooling water to pass through the coils. This water is not only heated by this procedure to its greatest amount, thus resulting in a diminished efficiency in the operation of the pump, but the aqua ammonia itself is carried back to the generator before it absorbs its full quota of gas. The result here, as well, is a diminution in efficiency. The ammonia pump must circulate more aqua ammonia through the system and the system and the steam loss here is considerable. Again, the aqua ammonia gives out heat when it leaves the generator, and an increase in the amount of aqua ammonia circulation merely means another leak for heat of very great amount from the generator. The modern machine utilizes the interchanger to utilize this heat somewhat.

The comparatively cold, strong liquor as it leaves the absorber is heated by the hot weak liquor leaving the generator by an interchanging device used with this object in view. If the system is operated at unusual speed or unusual temperature, the result is again that this interchanger does not operate satisfactorily.

The fact of the matter is essentially this: Both the absorption and compression types of refrigerating machines are either efficient or inefficient, dependent upon design and operation. A compressor, with a very large clearance and leaky valves, will produce little or no refrigeration and will have a very large steam consumption. The absorption system, in turn, with poor design and poor operation will, in turn, produce little or no refrigeration, since all the ammonia gas may be reabsorbed by condensed water in the dehydrator or water collected in the ammonia condenser proper. The operating engineer who would allow his compressor to get out of order to the extent that the valves never closed completely and, further, did not keep enough ammonia in the receiver to prevent passage of the ammonia gas through the expansion valve, would be considered a very poor operator. Exactly similar conditions to this exist every day in the operation of the absorption plant, and it is only due to the fact that the machine can be speeded up relatively very much to counterbalance these defects, and that the defects themselves are invisible or at least not perceptible to the ordinary senses, that they would not be at once self-evident.

This represents exact conditions in the operation and construction of the modern plant. Comparatively few are operated with any attempt at attaining maximum theoretical efficiency or with any real knowledge in regard to the temperatures desired and the pressures and condensing temperatures favorable for the operation of the various units. Good absorption machine operators are in great demand, but the average absorption machine manufacturer thoroughly believes that it is absolutely necessary for him to teach from the beginning, every detail of the absorption plant to the operating engineer. He believes this as the result of long and sad experience in the operation of his plants, and the operating engineer who at one time possible operated an inefficient type, and has no knowledge of modern possibilities in this field, is apt not to pay the proper regard to the small and even seemingly insignificant requirements demanded. That the operatng engineer should attain a more complete knowledge of this department and become a firm believer in the possible high efficiency of the absorption type, and should further make an attempt to master the knowledge necessary for satisfactory and efficient operation of these units, is almost the foremost wish of the average absorption machine manufacturer.

Packing for Pump Rods.

EDITOR THE PRACTICAL ENGINEER:

In reference to R. C.'s question regarding the packing of a pump rod, the writer has been using the three and the four wedge packing ever since the manufacturers began to make them and they are the only style that have given me entire satisfaction on pump rods for both the steam and the water end, the pump using either hot or cold water.

Depew, N. Y. C. W. D.

BOILER FIRING WITH LIQUID FUEL

Methods of Installation and Regulation to Produce a Good Fire

By A. S. Atkinson.

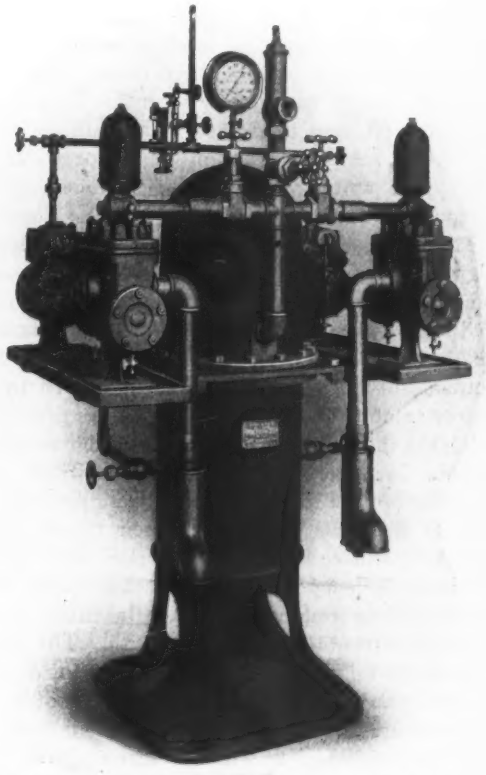
The extent and success which firing with liquid oil has attained on the Pacific coast has naturally given publicity to many experimental tests with various kinds of burners, grates and spray pumps. Experience has demonstrated that almost perfect combustion of the liquid fuel can be obtained where there is a proper mixing with the air, and the regulation of the heat has become so simple that with the aid of thermometers each boiler of a series can be fired separately without waste of any kind or in combination with a battery. The abundant presence of oil in California is sufficient inducement for steam users to locate on the Pacific coast, and the growth of central generating stations has been almost as phenomenal as the development of California's hydro-electric plants.

The burning and control of the oil in the furnace are technical questions which have been satisfactorily solved. Both the straight-blow and cross-blow burners are used in many of the large power generating plants, and while each has certain features which make it of special value the advantages of economy or ease of manipulation are possessed by neither to the exclusion of the other. Practice in California steam plants indicates that where it is desirable to convert a furnace from coal to oil or back again to coal, the cross-burners are the best, for it is somewhat difficult to set the stright-blow burner, and a good many changes have to be made in the brickwork of the furnace. While it may take two or three days with the cross-burner to convert a furnace from coal to oil, only an hour or less is required for reconverting so that coal can be used. But in California there is less and less coal being used, and the convertibility of the furnaces in short order is of minor consideration. In other parts of the country, where it may be more desirable to use both coal and oil alternately, or to be prepared for liquid fuel burning when cost of coal is excessively high, the convertibility of the furnace is really of vast importance.

In installing the straight-burner the bridge wall of the furnace has to be reconstructed and a grillwork of firebrick put in its place. Moreover the grate bars have to be lowered nearly a foot and a double row of firebricks laid on top. This forms a sort of air chamber through which all air must pass to reach the furnace. The purpose of this is to heat the air before it comes in contact with the fire. With two cross-burners set up under each boiler, the heated air is mixed in proportions with the oil. The oil is forced through a small hole in the brass casting of the straight-blow burner, and the steam coming in contact with it from an outside brass tube whirls it around and atomizes it for burning.

In installing a cross-blow burner the grate bars are not moved from the position used in burning coal, but they are covered with a layer of firebrick laid in mortar. Both the bridge wall and the furnace doors are left unchanged, but the layer of firebricks cover the entire grate except for a few inches in front for the admission of air. The oil in this type of burner passes up through a central hole in a small brass casting, and flows out through small holes arranged on the under side of an overhanging top in the form of a semi-circle. The steam issues in a sheet from a slot in the burner, and it immediately spreads and atomizes the oil.

As the whole success of oil burning depends upon its perfect atomizing, so that it will mix with air, the design and installation of the burners are most important. Unless the oil is minutely separated by the steam, good combustion is impossible. The pressure of the oil through the burners must also be steady and uniform or else the fire changes,

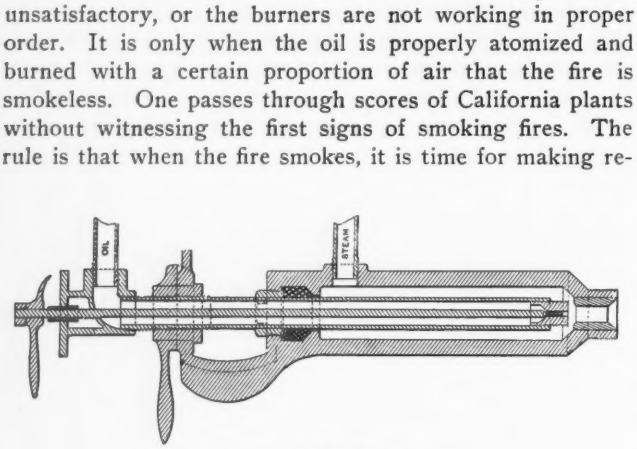


Fuel Oil Pump, Heater and Pressure Regulator

and the spraying of the steam fails to secure the desired results. A good deal of trouble has been experienced in burning oil fuel in the past, and California steam users found their fires going out or changing rapidly in temperature. Unsteady pressure of steam or oil supply were accountable for most of this trouble, and today this trouble has been largely, if not entirely, removed. The best oil burning practice is found to-day on the Pacific coast, and this may be noticed by an examination of any of the plants.

The proof of it can be found by an examination of the chimney, the ash pit, and the grate. Where the burners

do not work properly the fire smokes badly. If such a sign is visible in a California steam plant immediate repairs are made. Either the pressure of steam or oil is irregular and unsatisfactory, or the burners are not working in proper order. It is only when the oil is properly atomized and burned with a certain proportion of air that the fire is smokeless. One passes through scores of California plants without witnessing the first signs of smoking fires. The rule is that when the fire smokes, it is time for making re-



Section of Oil Burner

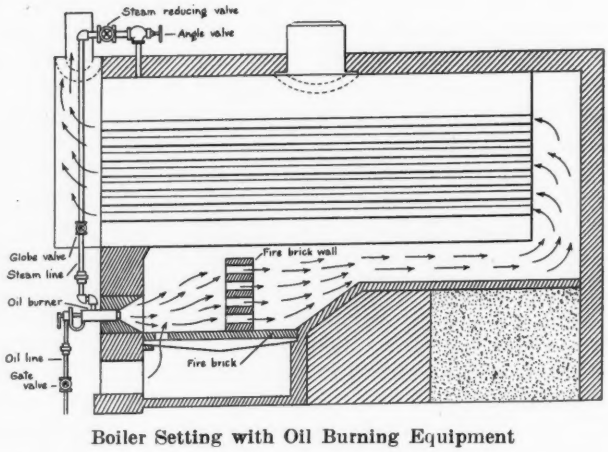
pairs. When the pressure of oil decreases the steam is very apt to blow out the fires and cause a shut-down, and when the steam pressure decreases there is an excess of oil supplied, which cannot be properly burned. This excess flows into the ash pit, and if allowed to accumulate, may cause an explosion. An examination of a dozen large steam plants by the writer showed ash pits almost as free from oily deposits or drip as one could desire. Some of them were examined critically and a lighted match failed to cause any ignition.

Sometimes the oil that is not properly atomized and burned flows away and is lost, so that an accumulation may gradually be made in other dangerous parts of the furnace, but outside of the question of danger caused by this, the imperfect combustion of the oil causes the greatest trouble in filling the tubes with a soot that is harder to remove than coal soot. Managers of some old plants which used oil in the days before the modern burners were perfected, assured the writer that this soot ruined their tubes and made it necessary to replace them with new ones about once a year. The loss of efficiency through the accumulation of this soot was greater than from boiler scale. But in the best practice of to-day this trouble is rarely met with. The collection of soot is almost nil, and a plant may be run for decades without showing any material accumulation of soot in the tubes.

The pressure of the oil has been regulated by an auxiliary air chamber, which works with automatic regularity. Opening into this air chamber is a small safety valve. The pressure of the oil is steady, either from tanks overhead or by duplex pumps, but in burning the liquid fuel this pressure may at times prove excessive. When the pressure runs above a certain point the safety valve in the air chamber operates to return the surplus oil to the storage tanks. There is consequently little danger or trouble from this source in burning oil, although in some crude installations where this auxiliary air chamber is omitted, danger and loss are constant factors, requiring eternal watchfulness on the part of the engineer to prevent an explosion.

One of the great advantages of oil burning is the comparative simplicity of starting and regulating the fire. By turning on the steam and the oil and throwing a piece of blazing waste in the fire box an immediate hot fire is secured. The regulation of the fire depends upon the force of the oil supply and atomizing steam. By simply reducing the pressure a slow fire can be maintained. It is possible to secure complete combustion in the modern plants with a small fire as with a full one. Success has not alwaye been attained in this respect, however, and much depends upon the skill of the fireman. In order to keep a low fire he must turn on the pressure of oil and steam until no smoke is emitted. It requires a little patience and study to accomplish this in some plants, and a careless engineer or fireman may leave his fire in a smoking condition over night. Efforts have been made to overcome this by automatic equipments, which make it impossible to change the proportionate pressure of the two. When the feed of oil is reduced the spray of steam is automatically cut down to accommodate the pressure of the oil. This simple arrangement has eliminated one of the disadvantages of oil burning on the Pacific coast.

In the early experiments with oil burning in California there were many predictions of accidents and injury to boilers, which subsequent experience has hardly borne out. It is true that a number of explosions were recorded. Fires, for one reason or another, went out, and explosions occurred which blew out the front of the boilers. It was found that the gas from the oil, when combined with the air in certain proportions, was very explosive, and the heat of the furnace was sufficient to ignite it. Most of the boilers were provided with peep-holes in the back, so the fireman could watch his fire. This necessitated close and constant watchfulness, and a short absence from his post of duty might cause the loss of the fireman's life and others employed in the engine room. To-day such watchfulness is supplemented by automatic alarms. By means of electrical devices, when the fire is extinguished accidently, an alarm



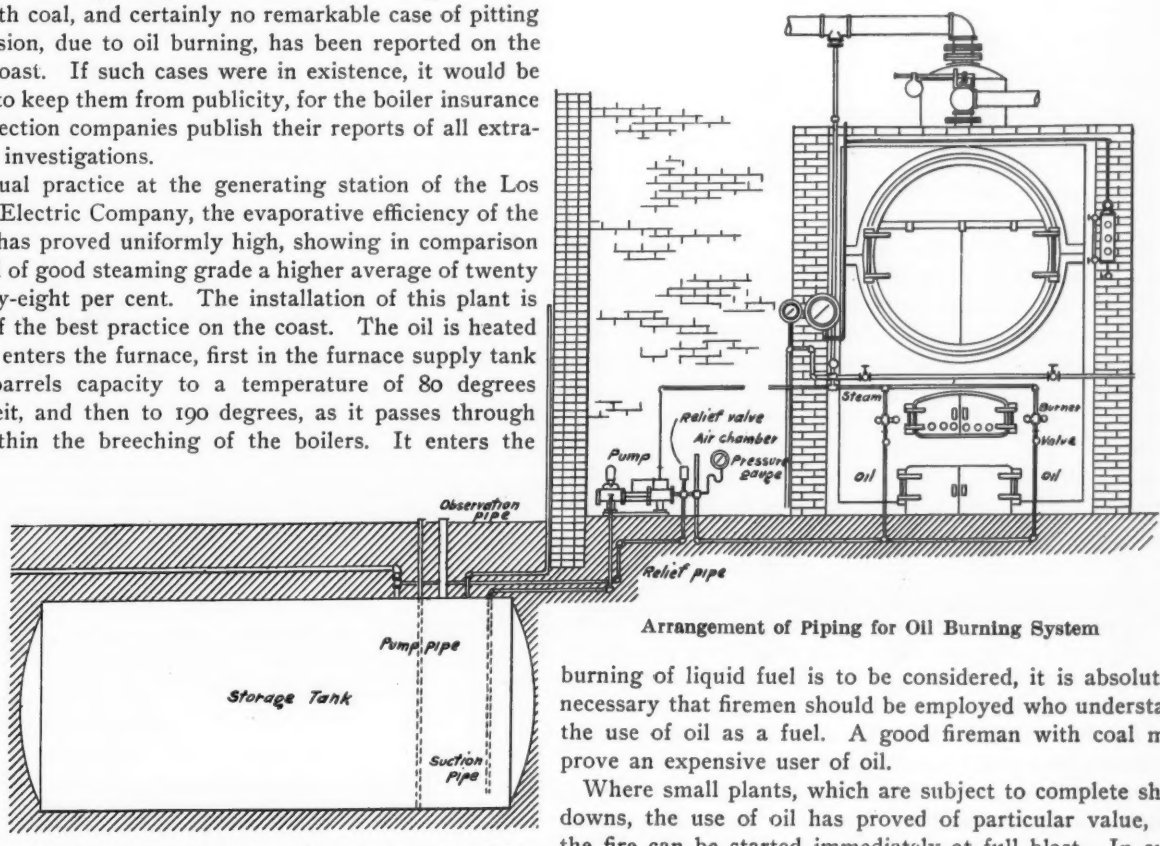
Boiler Setting with Oil Burning Equipment

is rung, and no damage can thus result. This improvement is directly in the line of scientific steam engineering, which adds, so far as possible, mechanical safety devices to the human element of uncertain watchfulness.

The question of the relative injury to boilers and furnaces when liquid fuel was used has been satisfactorily answered by the boiler and inspection insurance companies. None of

these hesitate to insure boilers fired with oil at the same rates charged for those fired by coal. On the Pacific coast no distinction is made between the two insurance risks. The wear and tear upon the boiler structure is generally considered less with oil than with coal, and so far as the deteriorating effect of boilers, such as pitting and corrosion caused by the amount of sulphur contained in the crude fuel may be concerned, the insurance inspectors report the fear groundless. It is a question whether the amount of sulphur liberated per thousand heat units is as great with oil as with coal, and certainly no remarkable case of pitting or corrosion, due to oil burning, has been reported on the Pacific coast. If such cases were in existence, it would be difficult to keep them from publicity, for the boiler insurance and inspection companies publish their reports of all extraordinary investigations.

In actual practice at the generating station of the Los Angeles Electric Company, the evaporative efficiency of the burners has proved uniformly high, showing in comparison with coal of good steaming grade a higher average of twenty to twenty-eight per cent. The installation of this plant is typical of the best practice on the coast. The oil is heated before it enters the furnace, first in the furnace supply tank of 100 barrels capacity to a temperature of 80 degrees Fahrenheit, and then to 190 degrees, as it passes through pipes within the breeching of the boilers. It enters the burners at this latter temperature, where it is sprayed by steam in the form of a fantail spray. The oil is sufficiently broken up to ignite by the heat of the brick lining of the furnace, and the flame fills the entire furnace box, so that every part of the boiler comes in contact with it.



Arrangement of Piping for Oil Burning System

Each burner has an evaporation efficiency of 3000 barrels of water per hour. The oil is fed to the burners under twenty pounds guage pressure by a pair of duplex pumps. The combustion causes very little noise, and there is absolutely no colored gases leaving the smokestack. In the smokestack there is placed a high-temperature thermometer, which enables the fireman to graduate the amount of air necessary for perfect combustion. So well does this work that the fireman can raise the temperature of the gases in the stack from 450 degrees to 600 degrees Fahrenheit, by simply closing the ash pit door one inch. Now, in operating a battery of boilers it is necessary, in economical generation of electricity, to change the load quickly and frequently. It is possible, with the use of the stack thermometer, to do this so that each boiler will do the amount of work required of it with the least possible loss of time and labor.

Good firemen and engineers are as essential in firing with oil fuel as with coal, and no automatic inventions have yet been made to eliminate the human element entirely. The regulation of the fire comes as a matter of experience and skill. A good fireman will keep the evaporative efficiency of the burners high. A poor fireman will permit a burner designed to consume five per cent. of the steam which it evaporates, consume as much as twenty per cent. It is all a matter of skillful control of the plant. If economy in the burning of liquid fuel is to be considered, it is absolutely necessary that firemen should be employed who understand the use of oil as a fuel. A good fireman with coal may prove an expensive user of oil.

Where small plants, which are subject to complete shutdowns, the use of oil has proved of particular value, for the fire can be started immediately at full blast. In such cases, however, there is needed a small auxiliary steam generator to supply the steam jet to spray the oil. The amount of steam required to spray the oil is small, varying from one to three per cent. of the steam generated. But when this is deducted from the cost of operating the plant, the economy and efficiency of oil firing are large enough to make it of value in parts of the country where liquid fuel is abundant. The development of oil firing for steam on the Pacific coast has given to engineers generally a most conclusive test of the relative value of liquid fuel in comparison with coal.

The bulging of plates between staybolts is usually due to overheating, just the same as in furnaces of internally fired boilers, or in the bottom plates of horizontal return tubular boilers, and it is not usually due to weakness of design. In other words, bulging is due to abnormal conditions of operation, and may be prevented by care in operation rather than change in design of the size and pitch of the staybolts.

THE HORIZONTAL HYDRAULIC ELEVATOR

Practical Pointers About Packing Operating Valve, Shortening Cables, Packing Plunger and Putting on New Cables

By R. Cederblom.

The "pushing" type of the horizontal hydraulic elevator has been very extensively used in all kinds of buildings requiring an elevator, and as any engineer who has had no previous experience with elevators is likely to run across this piece of machinery at any time in change of position, a few hints in

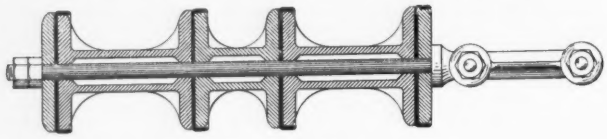


Fig. 1

regard to the care of same may not be amiss. As a rule this type of elevator gives the operator very little trouble; the wear and tear is small, on account of the slow motion, which also facilitates inspection at all times, and when it does require attention it is generally due to leakage in the plunger or in the operating valve. The operating valve is of the piston type, packed by leather cups, inserted between distance pieces, as shown in Figs. 1 and 2. Fig. 1 shows the construction when the car is controlled by a lever; Fig. 2, when a tiller or hand

Fig. 2

rope is used. Leakage of the operating valve is readily shown by the creeping of the car at middle floors.

When the lever construction is used there can be no possible mistake about the position of the valve when replacing the rams after renewing leather cups. With a tiller rope, however, which necessitates the use of rack and pinion, it is advisable to mark a tooth in the pinion relative to its position in the rack before withdrawing the valve, so as to get the valve in exactly the same position it was before removal. If not, it will be found necesary to shift the tiller rope on the operating

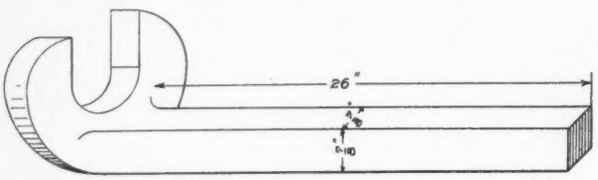


Fig. 3

sheave or adjust the buttons on the rope at top and bottom of well, as these buttons act as automatic stays at top and bottom of landing. To pack the piston or plunger is more of a job, but a properly packed piston should run from six months to a year, if some lubricant is used in the water and the cylinder swabbed with oil once in a while.

A very handy tool in packing the piston is the wrench shown in Fig. 3. The shank should be $\frac{7}{8}$ inches square and about 26 inches long, the head to fit the nuts on the gland or packing ring.

When ready to pack the piston, run the car up to within twelve or eighteen inches of extreme travel and tie the car in that position to one of the beams overhead. Not running it clear up will facilitate refilling the cylinder. After the car is suspended throw lever or tiller rope in down position, close valve in supply pipe and empty out the cylinder through drain pipe provided for this purpose, at the same time opening the pet cock to let in air.

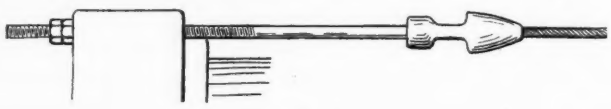


Fig. 4

While waiting for the cylinder to get empty, remove the buffer and packing ring and shove them both out of the way and place a jack screw underneath the piston rod to hold the piston in centre of cylinder; or it may be found difficult to enter the packing under lower half of piston. The packing used for this kind of elevator is generally one-inch-square flax. When cutting the new packing, make the rings about four inches longer than the exact size of cylinder (one of the old rings is handy for a measure), and after they are well soaked in oil put them in position with ends abutting. As the ring is four inches too large it forms into loops; divide these evenly and ram in packing in five or six places with handle

Fig. 5

of wrench (Fig. 3), after which the loops are easily taken care of, and the result is a ring that will fit snugly and last a long while.

When the packing is in place, compress the same evenly with the ring or gland by tightening a little at a time on each nut until packing is fairly well compressed. Replacing the buffer will finish the job, and although too heavy for one man, it can very easily be swung into place by using a piece of timber for a lever with one of the rails for a fulcrum.

When refilling the cylinder, throw the operating valve in up position, and open the valve in water supply pipe just a trifle; if water is allowed to rush in too fast some of the air is sure to remain after cylinder appears to be filled and will cause trouble when car is started.

When greasing the guides, do not use the lubricant too freely

or the guide shoes will scrape it off, and falling from a great height, it is liable to land where least wanted. Some engineers use oil for this reason instead of grease. The writer prefers a mixture of cable grease and cylinder oil, which can be applied in a thin coat with a brush while hot. This mixture will not dry up as quick as oil, and at the same time it sticks to the guides and gives good satisfaction as a lubricant.

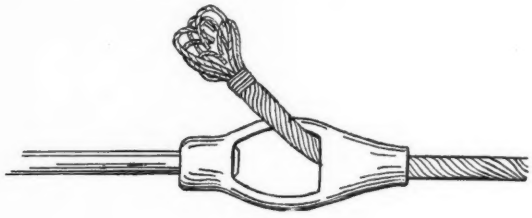


Fig. 6

Another operation that is necessary, is shortening the hoisting cables. On high lifts a new set of cables will stretch from ten to twenty inches in a few weeks and even after years of service they will have to be shortened once in a while. The cable ends are fastened, as shown in Fig. 4, and if the car strikes the bottom of well this can be remedied by tightening up on the nuts the required distance. This is easiest done by blocking the car five or six feet from bottom of pit, the chances being that holes are provided in the guides to receive pins for the car to rest on.

When the car is blocked throw the operating valve in down position (always close the water supply valve or some fool of an operator may start the car while you are working on it), and pulling on the cables will force the piston inward and give you all the slack wanted. If cables have already been taken up until no thread is left, a piece of pipe slipped over the rod will help you out for awhile, as shown in Fig. 5. If no more can be taken in, the cables must be cut. The ends are fastened, as shown in Fig. 6, and when cuttting the cables remember it takes about seven inches for the bend inside the socket. Before cutting off the cables tie a string around it near the place of cutting to keep it from unravelling. The babbited part inside the socket is easily removed by cutting flush with socket and forcing down with hammer and pin the size of cable. Take one at a time, so that there can be no possibility of getting them mixed, as they are of different lengths. To provide room for the sockets, unravel about seven inches, bend the strands inward as shown, pull back into socket,

Fig 7

pour babbit in between the strands and the job is done.

If a new set of cables are required and you prefer to do the job yourself, proceed as follows: Place the coil of new cable on a reel. Trying to unwind the steel rope any other way is injurious and generally results in a damaged rope, then cut one of the old cables where it is fastened to top of car. You will find the cable fastened here in a cone-shaped socket in the same way, as already described. Tie a wire around the cable about 12 inches from the end, make a loop of one strand, as shown in Fig. 7; cut off the rest and do the same with the loose and new cable. You will then have a splice that will readily pass over the sheaves and under the guards. Now, station a helper at the reel, to pay out the new cable as fast as the old one is pulled off the sheaves down below. When all the ropes are in place, fasten the ends in top of car first, then hitch up some pulley arrangement at the other end to stretch the cables and mark where to cut off for the rod sockets. It is advisable to cut the cable so as to leave the car about six inches above the floor, as the ropes will stretch that much the first day.

A TALK WITH A CHIEF ENGINEER

Some Practical Information on the Construction and Strength of Riveted Joints

By William Kavanagh.

Talk No. 9.

After his last talk on the measurement of candle-power of lamps and the formation and application of vacuum, the Chief promised to give Kingsley some practical pointers on how to obtain a first-class license. I arrived just as he was beginning to give Kingsley some advice, as I had some minor details in my own engine room to attend to. "In my last talk with you," said the Chief, "I promised to give you some instructions, which you will find of great benefit when you appear before the Examining Board to try and obtain a first-class license. Of course, you know, Kingsley, that experience is one of the most important factors that will assist you in passing, but I want you to remember that when you present yourself before the board you will not be permitted to consult any books or ask questions. You will be dependent entirely on your own resources, and when you are asked a question don't become excited or try to answer the question in different ways. First, consider the question before answering it, and take your time. Measure the question in your mind accurately, to see if it contains any catch, or if it is capable of being misconstrued. When you answer, stop; don't try to extend it, because you might lead yourself into intricate matter which you might not be capable of explaining. Examiners like to see applicants extend their answers, and in this way they are able to judge the applicant's familiarity with the question.

"As the horizontal tubular boiler is the one most generally used to determine the applicant's knowledge of boiler construction, I will talk about it first. A knowledge of boiler construction is as necessary as a knowledge of boiler operation before you can pass an examination for a first-class license, and if you are ready to take notes on this subject, I will begin immediately."

Kingsley arranged his note-book, and the Chief proceeded:

"The steam boiler, when properly constructed, is an absolutely reliable piece of apparatus, but when improperly handled or treated, it becomes decidedly dangerous. It is, there-

fore, necessary to understand the correct handling of the boiler in order to prevent disastrous consequences. In this talk, however, I will assume you are familiar with the correct method of maintaining the boiler in a reliable operative condition, so that I will not enter upon this subject, but will proceed to elucidate some of the principles of construction, in which we are all interested.

"Without entering into a useless and lengthy definition found in text-books, I will define a steam boiler as a vessel in which heat-energy is stored. This is a practical definition, and will be accepted by examining engineers. The material out of which it is built and the methods employed in its building are merely matters of detail, and are not necessary to inject into the meaning of the word "boiler." The theoretical boiler is one in which no rivets are used in its construction and the strength of the shell or cylinder is equally distributed around its circumferance. Practically, however, seams must be used. Some very good seams are produced by means of electric welding, but since this method of joining the plates is limited, it will only be necessary to consider boilers having riveted seams.

"In considering the theoretical boiler, it can be assumed that the boiler is constructed without rivets. Suppose, then, we

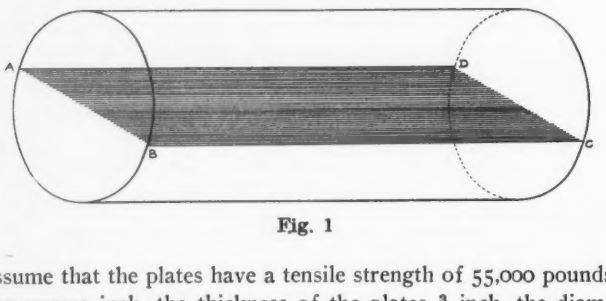


Fig. 1

assume that the plates have a tensile strength of 55,000 pounds per square inch, the thickness of the plates $\frac{3}{8}$ inch, the diameter of the boiler 66 inches, and the length of the boiler 14 feet. To find the pressure that will burst the boiler along its side, multiply the thickness of the boiler plate by its length in inches and multiply by 2 (because there are two sides in the boiler to be broken), and we will find the area of the metal that will resist the pressure in the boiler. Reducing the length of the boiler to inches, we have $\frac{3}{8} \times 168 \times 2 = 126$ square inches of metal. If we multiply 126 by 55,000 we have 6,930,000 pounds as the necessary load to rupture the cylinder."

At this point the chief drew a sketch similar to that shown in Fig. 1, and, having drawn the parallelogram, A, B, C, D, the Chief continued as follows: "You see, Kingsley, I have drawn a parallelogram through the axis of our theoretical boiler, so that if we divide 6,930,000 by the area of the parallelogram we will obtain the pressure per square inch that will burst the cylinder. The area of this parallelogram is equal to its length multiplied by its width, and this equals 66×168, or 11,088 square inches, so that $6{,}930{,}000 \div 11{,}088 = 625$ pounds, the bursting pressure along its longitudinal axis. To find the bursting pressure that will burst the boiler pressure around the circumference, or parallel to its heads, we have a ring of metal, $\frac{3}{8}$ inch thick, whose length is equal to the circumference, and by multiplying this area, $3.1416 \times 66 \times \frac{3}{8} = 77.74$, by the tensile strength, 55,000, the strength to burst it endwise will be 4,275,700 pounds. The force acting to burst the boiler endwise is equal to the diameter of the boiler times its pressure, and since the area is 3,421 square inches, the pressure per square inch that will rupture the boiler lengthwise will be $4{,}275{,}700 \div 3421 = 1250$ pounds. So, you see, Kingsley, it takes a pressure exactly twice as great to pull the heads apart as it does to tear or rupture the boiler

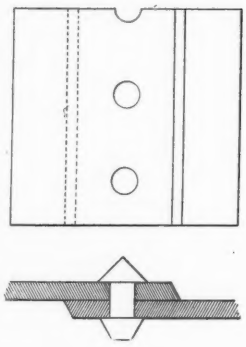


Fig 2

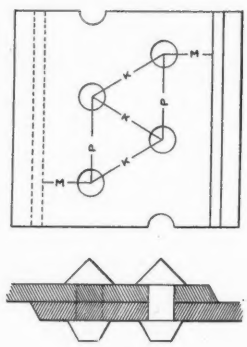


Fig. 3

along its length. For this reason you will find the majority of boilers are single-riveted on the girth seam while the longitudinal seams are double-riveted.

"Considering the practical side of the boiler if we multiply 625 by the percentage of riveted joint or seam and divide the product by a factor of safety, we will obtain the safe working pressure of the boiler. Suppose the seam is a double-riveted lap-joint and allow 70 per cent. for the efficiency of this kind of a joint, then $625 \times .7 = 437.5$ pounds, and if our factor of safety is 5, then $437.5 \div 5 = 87.5$ pounds, the safe working pressure of the boiler. If the boiler was properly constructed and handled, we could reduce the factor of safety to 4.5, so that we could carry a working pressure of 97 pounds, and, under favorable conditions, we could carry with safety a pressure of 100 pounds per square inch.

"There are three ways in which the strength of a boiler may

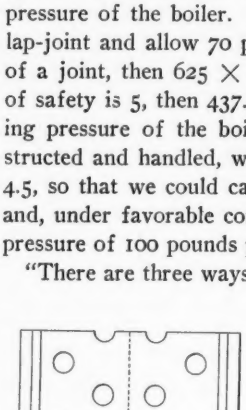


Fig. 4

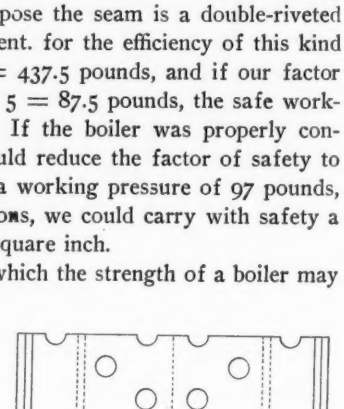


Fig. 5

be increased: First, by increasing the thickness of the shell; second, by adopting a more improved form of riveted joint; third, by reducing the diameter of the cylinder. By reducing the diameter, the heating surface will be reduced, and, therefore, the steaming capacity. For this reason, it is best to use the strongest forms of riveted joints used," said the chief, as he drew sketches similar to Figs. 2, 3, 4, and 5, "and they all

reduce the strength of the solid plate, but some more than others. The joint shown in Fig. 2 reduces the strength of the plate nearly one-half. This style of seam is seldom used, except with the cheapest form of steam boilers. The double-riveted joint shown in Fig. 3 reduces the strength of the solid plate about 30 per cent., the style of joint shown in Fig. 4 reduces the strength of the plate 25 per cent., while the method of riveting the plates together, as shown in Fig. 5, reduces the strength of the plate 20 per cent.

"The style of riveting shown in Fig. 4 is called the butt-strap, double-rivet joint, and, when properly made, is far superior to the lap-joint shown in Fig. 3. The style of riveting shown in Fig. 5 is called the double-strapped butt-joint, and is usually triple-riveted. When this form of joint is used, the plates only lose from 15 to 20 per cent. of their original strength, hence it is the joint to use if great strength is required. You will notice that the upper and lower row of rivets are pitched further apart than the other rivets, and they take hold of the inner strap. Should these rivets be pitched as close together as the double rows, the strength of the plate would be reduced 30 per cent.

"The object to be attained in all riveted joints is to make the strength of the riveted seam approach the strength of the solid plate as closely as possible. It is impossible to punch or drill holes in a sheet of boiler iron and then expect this sheet to retain its original strength; hence, if the holes to receive the rivets are so pitched as to have the metal between the holes as strong as the rivets, the riveted seam will have its greatest strength. If the rivets are pitched very close, the metal between the rivets will be weakened; therfore, it is important to pitch the rivets at such a distance as to obtain the strongest joint. If the rivet holes are drilled instead of being punched, the metal around the rivet holes will be stronger and a better seam can be made than if the holes were punched. Punching the plates destroys the molecular structure around the holes and weakens the seam. Drilling is an expensive method, and in order to overcome the disadvantages of punching and obviate the expense of drilling, some boilermakers punch a smaller hole than the rivet requires, and then ream out the hole to the required size. This latter method is a great improvement over the old-style method of punching the holes to their full size.

"The pitch of a rivet equals the distance from the centre of one rivet hole to the centre of the adjoining rivet hole. If you are required to find the strength of the metal between the holes, you must multiply the distance between the inner edges of the holes by the thickness of the plate, and then multiply this product by the tensile strength of the plate.

"Riveted joints may fail in any one of the following ways: First, by shearing the rivets; second, by tearing the plate between the rivets; third, by tearing the plate between the rivet edge of the plate."

In order to make this more plain, the Chief drew a sketch, similar to Fig. 3. He explained that if the rivets were placed too close together, the metal at P, P, P would become weakened, and if they were placed too close to the edge, the metal at M, M, M would fail. The Chief also explained that the distance M was equal to 3 diameters of the rivet divided by 2 and P = 5 diameters divided by 2; that is, if d = diameter of rivet, then

$$M = 3d \div 2, \text{ and } P = 5d \div 2,$$

and for the diagonal pitch,

$$K = (6\ P + 4d) \div 10.$$

The Chief said that no hard or fast rule could be given with respect to the riveting of a boiler seam, as different methods were employed in various shops. The diameter of the rivet was usually nearly twice the thickness of the boiler plate, but never less than the plate thickness. For single riveting, the pitch should be about 2½ times the diameter of the rivet, and for double riveting about 3 times the diameter. The Chief was particular to explain that the rivets shown in Figs. 2, 3, and 4 were in single shear, while the rivets shown at A, A, Fig. 5, were in double shear. Rivets in single shear have a strength of 38,000 pounds, while those in double shear have a strength of 70,000 pounds.

At this point the time for departure to our engine rooms was at hand, the Chief promising in his next talk to take up boiler setting and safety-valve setting and testing.

Advantages of Induction Motors.

The induction motor is, in all respects, the best type of machine for general power distribution on alternating-current circuits. It resembles the direct-current shunt-wound motor very closely in its general performance and is adapted to fully as wide a range of work; in fact, because of the absence of commutators and brushes, it can often be used in places where a direct-current motor would be liable to give trouble on account of dust, flying particles, or explosive gases.

The main advantages of the induction motor which have led to its wide use are:

(1) It starts under load. The starting torque may be varied as conditions require, and the machine can be started as readily as a direct-current motor.

(2) It runs at approximately constant speed, regardless of load, and if the load is suddenly thrown off, no racing can occur. The drop in speed from no load to full load is slight.

(3) It is extremely simple in construction, having no commutator or brushes; this insures absolute freedom from sparking, flashing or burning. The voltage in the rotating part is so low that insulation breakdowns do not occur.

(4) An induction motor, when started, does not require synchronizing, and hence does not call for the skilled attention that synchronous apparatus always entails.

(5) On account of its simple construction and absence of complicated auxiliary devices, the cost of maintenance and attendance is less than for any other type of electric motor.

These motors are adapted to the operation of all kinds of machinery and have special advantages for installation in cement works, powder mills, paint factories, flour mills, silk weaving plants, cotton mills, paper mills, mines, etc. If necessary, they can be installed in places not readily accessible, as they are easily adapted to distance control.

Essentially, they are constant speed machines, and best suited to work of that character, but by means of a suitable device they can be operated at variable speed, as in the case of the electric hoists for cranes, elevators, etc., which are now being built.

Power Plant of the Wiscassett Cotton Mills, Albemarle, N. C.

By Milton W. Arrowood.

A few years ago the town of Albemarle, located on the Norwood branch of the Southern Railway, was little more than a backwoods village, known only on account of its being the county seat of Stanly County. To-day, a resident of ten years back, returning to his native seat, would scarcely recognize, in the progressive young city of Stanly County, the easy-going village of earlier days. In a decade the town has had a number of fires, destroying the old frame buildings, as if it were in preparation for the erection of the modern brick structures now seen on every street. Stores have sprung up, hotels have been built, banks, trust and insurance companies, have prospered, and scarcely a year has passed that has not witnessed the establishing of some new manufacturing industry.

Street have been graded, water works have been installed, and many persons whose houses have heretofore been lighted with electricity from the mill plants are prophesying the coming of a city lighting plant in the near future. Interesting as all this may be, however, it cannot be discussed at length in an article, the chief purpose of which is to describe the power equipment used in one of the largest cotton mills, of the State of North Carolina. Perhaps the most vivid impression of one studying the machinery equip-

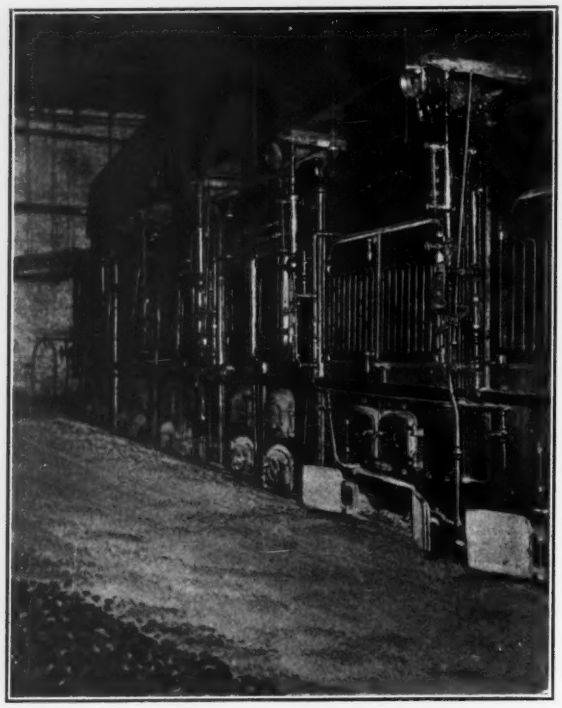


Fig. 1

ment, used to drive the mills of the Wiscassett Mills Company, is a realization of the fact that utility has been the by-word of the management. Nothing needful is omitted, and no piece of apparatus has been installed the practical use of which is not easily apparent.

In locating its mills, the company was fortunate in securing a convenient site, in the form of a narrow stretch of comparatively low and level land, lying along the tracks of the railroad, and adjacent to the banks of a creek from which ample water supply can be had for the greater part of the

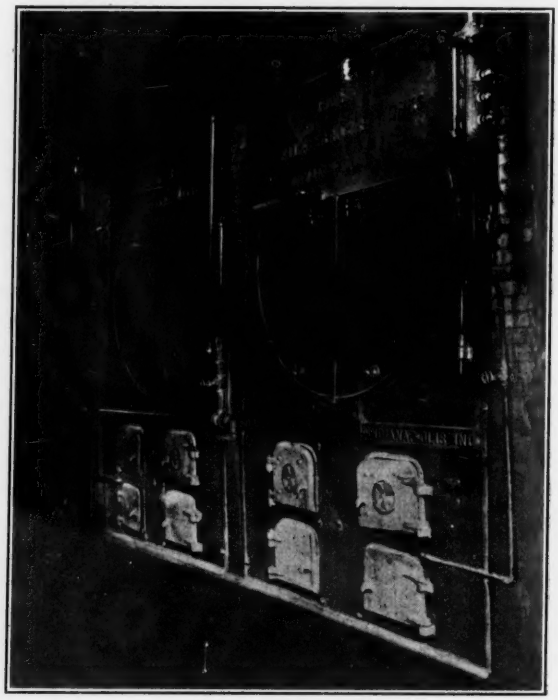


Fig. 2

year. Hills on every side afford excellent locations for the homes of employees. The plant consists of three mills, two engine rooms, two boiler rooms, shipping rooms, cotton warehouse and office. The engine rooms are adjacent to the boiler rooms, and the local office of the company between the main track of the railroad and a siding which passes in front of the shipping rooms and cotton warehouses.

Mill No. 3 stands next to No. 2, the latter containing a modern knitting mill in the lower story. A dye house for the hosiery produced, for this mill, is directly to the rear of Mill No. 2. The upper floor of this mill, and Mills Nos. 1 and 3 are devoted entirely to spinning cotton yarns.

The boiler equipment consists of a total of ten boilers installed in two boiler rooms, known, respectively, as rooms Nos. 1 and 2. Eight of the boilers, six of which are shown in Fig. 1, which is a view in boiler room No. 1, and two which are shown in the view of boiler room No. 2, as given in Fig. 2, have a capacity of 150 horse-power each, being horizontal return-tubular boilers fitted with safety water columns and standard steam gauges to register up to 300 pounds, the working pressure under ordinary conditions being 140 pounds. Four of the boilers shown in Fig. 1 were

built by the C. & G. Cooper Co., Mt. Vernon, O., while the other two were built by R. D. Cole Manfg. Co., Newnan, Ga., and the two units shown in Fig. 4, by the Atlas Engine Works, Indianapolis, Ind. The other two boilers, which

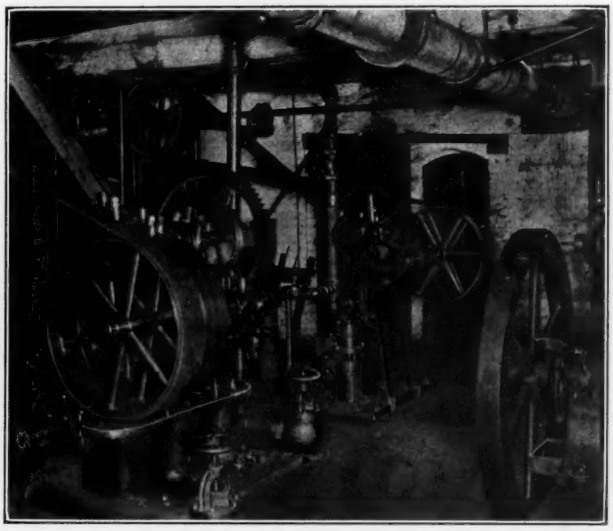


Fig. 3

are of the vertical type, as manufactured by the American & British Manfg. Co., of Providence, R. I., have a capacity of 250 horse-power each, and are installed in one end of boiler room No. 1. All of the boilers are connected to insulated steam mains, which go to engine rooms Nos. 1

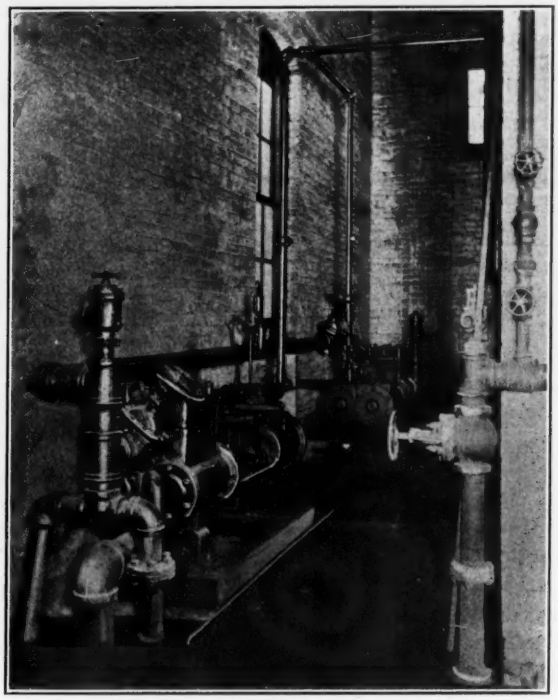


Fig. 4

and 2, passing over the roof of the shipping rooms and warehouse and being protected by suitable boxing, so as to be affected as little as possible by the weather. Coal for the boilers is brought on an elevated railway siding directly to the boiler room doors, where it is dumped from the cars and fired by hand. Feed water is taken from a masonry walled cistern, or circular supply well, about 12 feet in diameter and 16 feet deep, finished in cement, and is supplied to the boilers by power and steam pumps to be described presently.

Two of the vertical triplex plunger power-driven boiler feed pumps of which there are three, as shown in Fig. 3, are used for supplying the boilers in boiler room No. 1. One of these pumps, built by the Deming Co., Salem, O., is 5½x8 inches, while the other two, built by the Deane Steam Pump Co., of Holyoke, Mass., are each 5x8 inches. All three of the pumps operate at 40 revolutions a minute, and in addition to supplying the boilers through the feed water heater, they may be used to furnish water to the dye

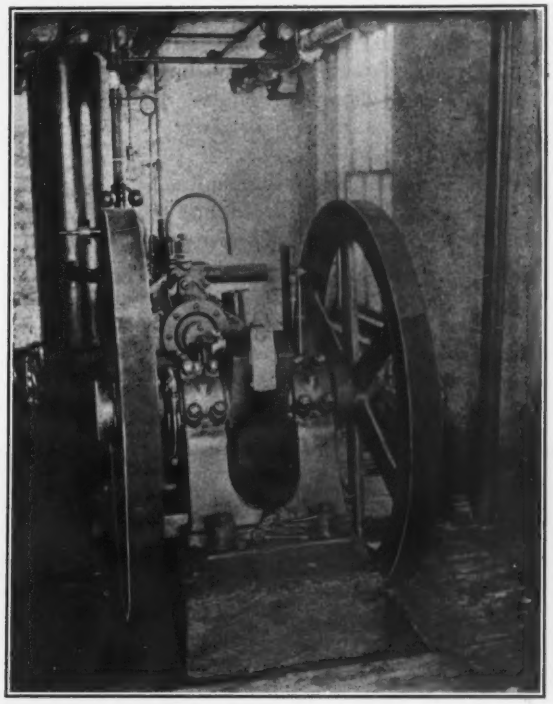


Fig. 5

house or for any other general supply purpose. A Worthington duplex, 6x4x6-inch pump, of the horizontal type, furnishes drinking water, and another similar duplex pump, 7½x4½x10 inches in size, is so connected that it can be used to pump water to the feed water heater, the stand-pipe used for fire protection, the house service mains or to the dye house. There is also a Worthington condenser pump, 12x14x10 inches used in connection with the condenser of engine No. 1.

Feed supply for the Atlas boilers is furnished by two horizontal Deane duplex steam pumps, one of them being 5¼x9x 12 inches, while the other is 6x10x12 inches. These pumps, with their piping connections, are shown in Fig. 4. When owing to dry weather the water supplied by the creek is not sufficient for the needs of the plant, the Hall air compressor, as shown in Fig. 5, is brought into service, to raise water from a well 325 feet deep. The pressure used for this purpose is 100 pounds and the compressor is 10x12x14

inches. Fire protection is had by a Worthington Underwriter, 18x10x12-inch pump, this pump being capable of furnishing 1000 gallons of water a minute, or the water necessary for four 7/8-inch hose nozzles when operated at 70 double strokes a minute.

Engine room No. 1 contains the engine originally installed to drive Mill No. 1, the engine being of the Cooper horizontal compound cross-connected type, 24x40x48 inches in size, used to drive two counter shafts by leather belts, 48 and 18 inches wide. The narrower of these two belts transmits the power for driving the card machines, located on the second floor of the building, while the main 48-inch belt drives the spinning room on the first floor. No. 1 engine is shown in Fig. 6, in the foreground of which is a small belt-driven generator, which can be operated by an 8x10 Atlas high-speed engine, not shown in the illustration, to furnish lights when the main machinery is shut down. A larger generator is used for regular lighting service in Mill No. 1. The switchboard for controlling the lighting circuits and the Locke damper regulator, used to control the draft of the boilers in room No. 1, are also located in this engine room.

When it became necessary to install additional power for driving Mills Nos. 2 and 3 it was found that sufficient cooling water could not be had to operate a compound condensing engine similar to that just described. It was therefore decided to install a horizontal cross-connected twin engine, having cylinders 24x48 inches, as shown in Fig. 7. In this case the rope transmission was used instead of belts, the engine being connected to drive two counter shafts, one of which, on the lower floor, drives the knitting mill, and

Fig. 6

is belt-connected to drive the 300-kilowatt, 220-volt, alternating current generator, as well as a smaller generator, which has a capacity of 240 amperes at 240 volts, when running at 900 revolutions a minute. The dye house is supplied with power from the counter shaft in the knitting mill by means of the rope transmission which passes through the wall of the mill. Lights for Mills Nos. 2 and 3 are furnished from the smaller generator, and the main generator is used to furnish current for the motors which drive Mill No. 3, this mill being operated entirely with motor drive on the group system. The generator is 3-phase, 60-cycles and furnishes 787 amperes per terminal when operating at 514 revolutions a minute. Its exciter is belt-driven direct from the counter shaft, and has a capacity of 200 amperes at 120 volts when running at 1050 revolutions a minute. Control of

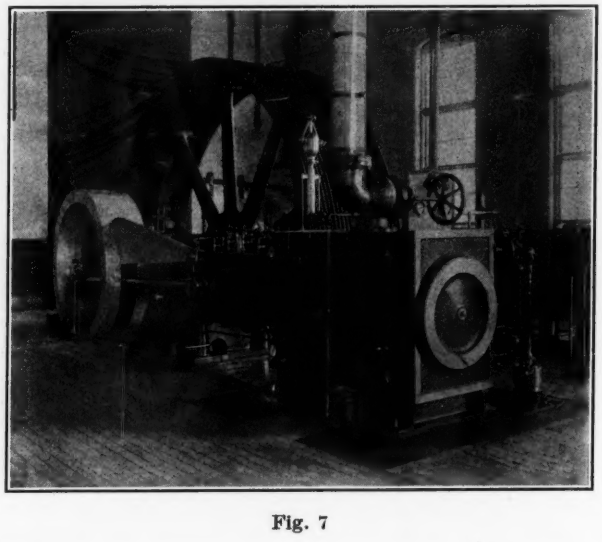


Fig. 7

the lighting and power circuits is had from a 3-panel, switchboard.

All heavy machinery, as engines and generators, is set on brick pier foundations, having heavy granite cap-stones, and the main generator is mounted on adjustable slides, so that the tension on the belt may be regulated. The pressure oiling system is used in both engine rooms, the oil being passed through a cross oil filter built by the Burt Manfg. Co., of Akron, O. Sheet iron oil guards are fitted around all moving parts, so that there is no waste of oil, and small steam-operated pumps in the basements of the two engine rooms return the filtered oil to the pressure tank. Tool cabinets and work benches, as well as clothes lockers, are supplied in each engine room, and for convenience in making repairs, there is a machine shop, containing two lathes, a drill press, a gear cutter, a power-operated hack saw, and a shaper.

Steam piping in all parts of the plant is laid out with ample regard to the needs of the case, and with provision for expansion and contraction, there being expansion bends wherever required. Steam is supplied from the water separators by independent pipes to each of the cylinders of the twin engine in engine room No. 2. The exhaust connections from this engine are connected to the feed heater and to the exhaust connection through the atmospheric relief valve, which gives free exhaust when it may be desirable. A third exhaust pipe connection is that made to the heating system of the mills, and in order that there may be no lack of heat, provision is made to use live steam through suitable reducing valves in case of necessity, the heating coils being carried in suitable racks suspended from the ceiling. Al parts of the mill are provided with a complete sprinkler system for protection against fire, and further than this, the rules of the underwriters are complied with in providing hose hydrants at suitable points, with plenty of hose.

Modern Views On The Transmission Of Electric Energy

Experimental Methods of Transmitting Current Without the Use of Wires

By C. Pagano.

The idea that the electric current is transmitted through a conductor, as a liquid in a pipe, has been the common and vulgar belief for many years. It was generally thought that the conductors were the exclusive place of the molecular movement which characterizes the current state and that the surrounding ambient was an obstacle to this movement. After the new and elaborate studies and experiments on the electric waves, we must admit that all the electric energy does not pass through the wire, but that it does pass through the surrounding ambient, and the small part of the energy that penetrates the conductors through their external surface is soon converted into heat. The experiments of Faraday, Maxwell, Poyntung and Hertz proved that the surrounding ether has a very great importance in the electric transmission.

The common parallel between an electric current and a liquid conveyed by pipes cannot sustain a severe examination. A liquid circulating in a pipe never shows external disturbances, while the electric current encounters many of these, as heat, magnetism, induction, etc. Hence, scientifically, the electric current is the centre of the perturbations in the surrounding ambient of the conductor through which it is conveyed under form of waves, such perturbations being due to the electro-magnetic energy transmitted.

In the moment when a current is produced, an electro-magnetic wave is generated and transmitted in the space around the conductor and is propagated as a luminous wave. When the intensity of the current is the same all around the conductor, the surrounding ambient is under a tension that is manifested by a tendency to contract in the direction of the lines of force and to expand in a direction perpendicular to them. Then the surrounding ether is in a state of equilibrium characterized by ½ cylindrical strata spread concentrically to the conductor, as shown in Fig. 1.

In order to well understand why the energy cannot effectively be transmitted by the usual means without wires, it is necessary to say that in such a case the energy would

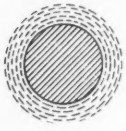


Fig. 1

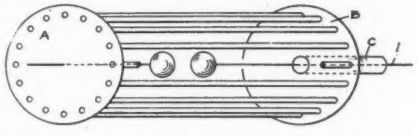


Fig. 2

flow in all directions and invade the infinite around us; while being compelled to follow the path of insulated wires previously arranged in the right direction, it becomes imprisoned around them and conveyed to the desired point. No part of it would penetrate the internal surface of the conductors, if these had practically "zero" resistance, but as this ideal condition is absolutely beyond practical possibilities, a small quantity of energy penetrates, as already said, the superficial strata of the conductors, and is wasted in heat and in other electrical effects.

Alternating currents generate continuous waves propagated in space in the same way as luminous waves. When these waves meet an opaque body they are absorbed and this absorption produces heat. Likewise, the conductors, when arresting electric radiations have currents induced in them which are manifested with thermal effects.

The electro-magnetic wave penetrates, more or less deeply,

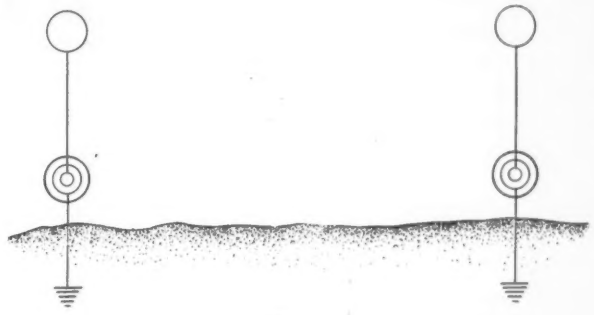


Fig. 3

the conductors, according to its length. The wave of short length penetrates, but only the superficial strata of the conductors which it meets along the path; hence the necessity of having a special form of conductor for currents of high frequency, as tubes, ribbons or metallic cords, instead of massive wires, as used for continuous current, which flows along cylindrical conductors with an even strength throughout their section. In the case of alternating current, the self-induction produces a deviation from this path, its reaction being stronger at the center than at the other parts of the wires, thus compelling the current to flow through the superficial strata.

The more variable the current is, or in other words, the higher the frequency, the stronger the reaction is, and hence the less deep the wave penetrates in the wire, the conclusion being, at least theoretically, that with a frequency of millions of cycles per second, the flow of current would be confined to the very skin of the conductor. A practical experiment confirming this hypothesis was made by Dr. Hertz with an apparatus like a wire cage in which was imprisoned a small spark micrometer as shown in Fig. 2. A and B are two metallic disks, coupled all around their outer edges with wires of some length, the whole apparatus resembling a drum cage. G is a conducting tube, and I, a metallic wire. A is connected with the central wire, I, and B, wholly insulated from it, is in communication with the conducting body G, whose end is connected to I at *d*. By producing electrical disturbances in the neighborhood by discharges from an induction coil, no sparks could be perceived inside the cage, which always happens when the

central wire has no metallic protection. Changing these protecting tubes, G, from the thickest to the thinnest bodies and of several metals, it was proven that, no matter how vigorously the waves played around the outside of the wire, the whole inside of the wire was in perfect calm.

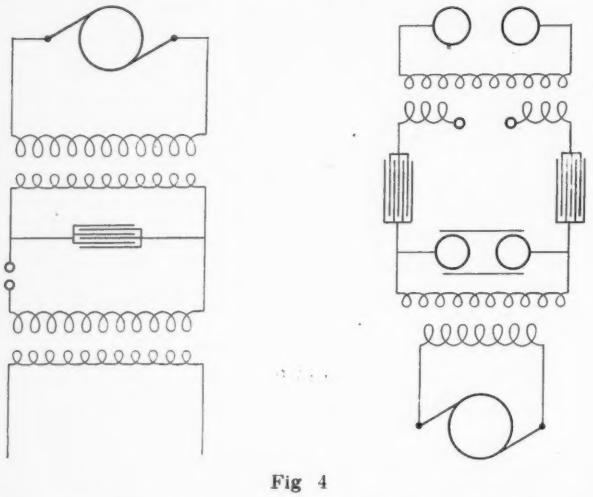


Fig 4

This experiment, together with others more elaborate, gives the chance to think that, effectively, the idea we had of insulators and conductors is fundamentally wrong; and as we put the matter for discussion, we will find that metals are, strictly speaking, non-conductors, but as they restrain, under some conditions, the electric energy from being dissipated, and compel it to remain concentrated around their surface, they become conductors of the apparent source of the electrical force.

As the electro-magnetic waves give up to the conductors a part of their own energy, and in order to destroy this dispersion of energy and recuperate the losses in a circuit of alternating current, the two conductors may be put near each other, as in the concentric type, so that the waves emitted by the first conductor reach directly to the other, to which they give back the irradiated energy under the form of induced currents. In this case of compensation, the circuit has no action at all on the surrounding space, and magnetic field is rigorously limited to the space occupied by the conductors and the di-electrics.

Although at the present day we still are using wires for the transmission of energy, with an awful expenditure of capital and labor, the time is not so far distant that this transmission will be done in a new way, and at great distances, through the intervening medium. Mr. Tesla, in his interesting experiments with high frequency and high tension, has succeeded in lighting lamps at some distance without wires, and he has even run motors, his principle depending on the production of rapid vibrations of the earth's potential. According to the plan of this distinguished scientist, when any source of alternating current is connected with its terminals to the ground and to an insulated body of large surface, as shown in Fig. 3, it sets up electric oscillation and a certain movement of electricity will be generated in and out of the large radiating body; alternating currents being able them to pass through the earth, "converging and diverging" from the grounded connection. In this way, points of neighboring places, the radius depending upon the quantity of electricity set in motion, could be disturbed and produce resonance effects in a receiving apparatus, ordinarily special coils, of which the inductance and capacity are so adjusted as to be in tune with the transmitting device. Clearly it is seen that although without wires, still the energy is transmitted by conduction, the method being radically different from Hertz's experiments as applied and developed in the wireless telegraphy, where the very small energy transmitted is radiated laterally in the space under the form of electro-magnetic waves.

That the air strata, under powerful electrical stresses, as generated by the high tension and high frequency impulses, become highly conductive, is proved by the fact that for a large area, sometimes several thousand feet in surface, the conducting body, to which the transmitting device is attached is wholly surrounded by a "flame." This visible discharge is limited to a certain radius of activity, but the stresses in an invisible manner still continue to influence the medium far from the disturbing center; in the same way, as it might be roughly imagined, a stone, thrown in a pool of water, generates a whirl with convolutions at the center, very crowded but gradually farther and farther apart, and larger, until it is extinguished in a movement almost invisible to the eye.

Transmission of energy by such powerful oscillations is already proved to be a practicable thing within certain limits and the terminal discharges more than a hundred feet long and with a deafening roar show that it would be comparatively easy to reach lengths hundreds of times greater.

How the effects of resonance are produced can best be explained by quoting the inventor's own words:

"Popularly explained it is this: When we raise the voice and hear an echo in reply, we know that the sound of the

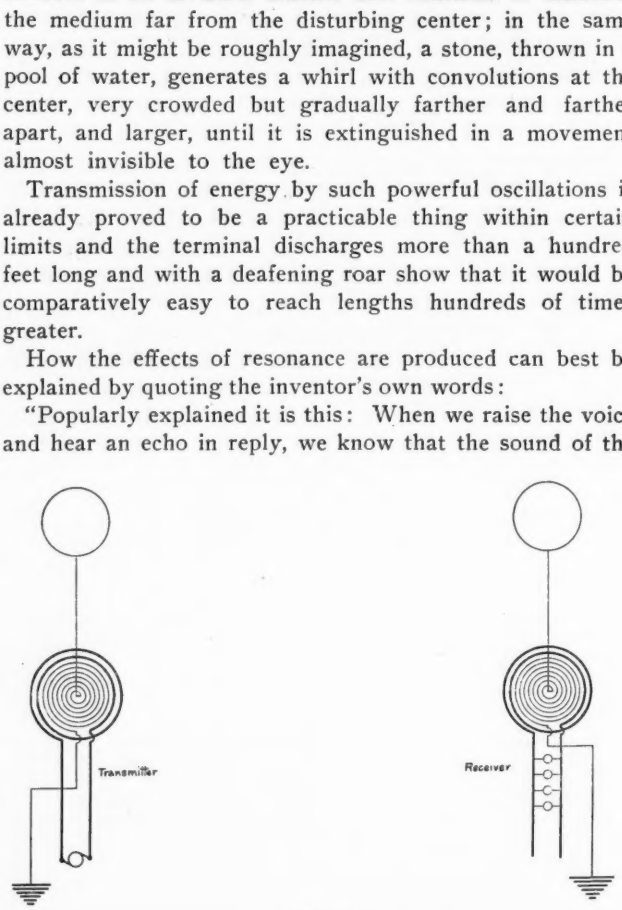


Fig. 5

voice must have reached a distant wall or boundary, and must have been reflected from the same. Exactly as the sound, so an electrical wave is reflected, and the same evidence which is afforded by an echo is offered by electrical phenomenon known as a stationary wave. Instead of sending sound vibrations toward a distant wall, I have sent electrical vibrations toward the remote boundaries of the

earth, and instead of the wall, the earth has replied. In place of an echo, I have obtained a stationary electrical wave, a wave reflected from afar. Stationary waves in the earth mean something more than mere telegraphy without wires to any distance. They will enable us to attain many important specific results impossible otherwise—among them the sending over the earth of a wave of electricity, traveling at any rate we desire, from the pace of a turtle up to the lightning speed."

Very high tension and high frequency are produced by a common source of alternating current, to which the primary of a transformer is connected, as shown in Fig. 4. The secondary, which already transforms the low potential of the source into high pressure, has in circuit a condenser, connected on one side directly to a primary of another transformer, the circuit being closed through an air gap placed on the other side. The current produced in the secondary of the first transformer charges the condenser, which will, by the disruptive discharges through the air gap, excite currents of enormous frequency in the primary of the second transformer, the secondary of which will raise the voltage to the last stage. This system is connected to what is called an oscillator, Fig. 5, the primary of which consists of a single turn of a large stranded cable, which has little resistance. This encloses a high tension coil, consisting of many turns of comparatively fine wire, heavily insulated, one side being connected to the ground, the other to a radiating body, the length of both conductors being determined by the wave-length of the oscillations. The receiving apparatus is almost the same, and includes the various circuits to be fed.

By this economical and direct method of transmission of the electrical energy, any powerful hydro-electric plant could send to innumerable long-distance receiving sub-stations enormous quantities of energy to be transformed at the proper tension and frequency, as required by the various industries and consumers. These central plants could freely send their energies without interference by using the Tesla system of tuning, by means of which the energy of each company could be individualized. The transmitters could be constructed to give simultaneously a certain number of vibrations and in a certain order, received by special tuned circuits, each responding to one of the transmitted vibrations.

No practical applications have yet been made of this wonderful system, however, the cause being chifly due to the difficulty of constructing special powerful oscillators capable to take charge of, and send through the air, thousands and thousands of horse-power; but we are living in a wonderful age of progress and what to-day is still beyond the practical means, will be to-morrow, probably, easily achieved and thoroughly applied.

METHODS OF SYNCHRONIZING ROTARY CONVERTERS

By Jacob Glogan.

When a rotary converter is started by any of the three methods viz., use of a separate motor, using the converter as a direct-current motor, and using the converter as an alternating-current motor, it must be in synchronism with the alternating-current bus-bars before it can be thrown in on the circuit. A machine is said to be in synchronism with another rotary when it is running with the same number of frequencies, when it is in the same phase and when the voltage of both machines, as recorded by a voltmeter, is the same. By frequency is meant the number of reversals of the electro-motive force per second, and by phase is meant that the armatures are in relatively the same position with respect to the poles or field.

The method of synchronizing rotary converters with machines which are already in operation, consists in bringing up the incoming rotary to approximately the same speed and voltage as the one which is in operation. When the machines have the same frequencies, phase and voltage, there will be no unbalanced voltage, and therefore no inrush of current when the machines are synchronized.

There are two different methods of synchronizing machines, (1) by means of lamps and (2) by means of the automatic synchronizer. Fig. 1 shows one of the principles of synchronizing when the lamp method is used. The two rotary converters to be synchronized are represented by R and R, and are connected through the switch by two series of lamps, shown at L and L. As the phases are different in the beginning of the operation, the synchronizing lamps will therefore receive the maximum and minimum voltage, causing them to burn bright and dim as the phases vary. If the two machines are in phase, then the electro-motive force of rotary No. 1 will oppose the electro-motive force of rotary No. 2, thus causing zero electro-motive force, or no light from the series of lamps. Therefore it will be understood that when the machines are in step the lights will be out and the connecting switch can then be closed. In this operation it is well to bear in mind that the operator, before closing the connecting switch, must be sure that the lamps will not brighten up, as serious trouble will result if they do. The switch should not be thrown in until all possibility of pulsating phase is gone, or in other words the lamps should remain dim for about ten seconds before the switch is closed.

Another method of synchronizing by means of lamps is to use transformers, and instead of connecting the series of lamps directly on the line as previously described, they are placed in the secondary coil of the transformer, as shown in Fig. 2. In this method the shunt transformer is used, the primary coils PC being connected directly across the line and the secondary coils SC are connected in series with the synchronizing lamps. When the two machines are running in phase and the transformers on the two circuits are connected in the same manner, there will be no light given off by the lamps, as there exists zero voltage. But if the primary coil of one transformer is connected differently from the primary coil of the other transformer, then, when the machines are running in phase, the lamps will be bright instead of dark. This is also the case

when the secondary coils of the transformers are connected differently. In practice, however, the dark lamp is generally used to indicate synchronism.

There is, however, an objection to the lamp system in that it requires a large difference of phase to make the lamps glow, and does not indicate whether the machine is running fast or slow, and show just how fast or how slow should indicate whether the machine to be synchronized is running fast or slow and show just how fast or how slow it is running.

An apparatus that fulfils these requirements is the synchronoscope. This instrument is provided with two pointers, one stationary and the other movable, and on the dial is indicated "fast" and "slow." Thus when the movable pointer is in the vicinity of that part of the dial marked "slow," it indicates that the incoming machine is running slow, and vice versa. When the two machines are in phase the two pointers will be together, and when the movable pointer slowly approaches the indicator, or stationary, needle, the operator gets ready to throw in the synchronizing switch.

To operate the synchronoscope it is necessary to connect two shunt transformers between the instrument and the bus-bars and another transformer must be used to connect the machines which are being synchronized. Fig. 3 shows the connections necessary for use with a Westinghouse synchronoscope.

The second method of synchronizing is by means of an automatic synchronizer. This instrument consists of two solenoids, one of which receives the maximum current and the other the minimum current. In order to make this action possible, one solenoid is connected in a manner similar to that used for synchronizing with a bright lamp, and the other solenoid in a manner similar to that used for synchronizing with a dim lamp. When the machines are running in the same phase the mechanical parts of the synchronizer are in a certain position, so that a contact is made which causes the operation of relays to the main synchronizing switch; thus performing the operation of synchronizing automatically. These instruments have proved very satisfactory and are being rapidly introduced in central station work.

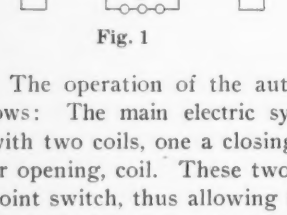


Fig. 1

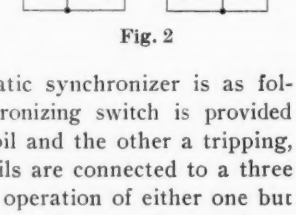


Fig. 2

The operation of the automatic synchronizer is as follows: The main electric synchronizing switch is provided with two coils, one a closing coil and the other a tripping, or opening, coil. These two coils are connected to a three point switch, thus allowing the operation of either one but not both simultaneously. A switch, known as the synchronizing switch, is used to connect the two solenoids with the potential transformers, one solenoid taking current from the bus-bars and the other from the incoming machine. Fig. 4 shows the connections for an automatic synchronizer.

When the machines are nearly in phase (allowing a few seconds for operation of the switches) the synchronizer closes the circuit of the solenoid on the relay switch and that promptly closes the closing coil circuit, thus operating the main switch which connects the incoming machine on the line. If, for any reason, the phases are changing too rapidly for paralleling, there is a certain attachment in the

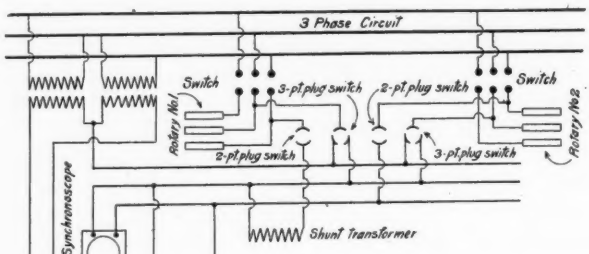


Fig. 3

synchronizer which withdraws one of the contacts, thus preventing the closing of the relay switch. By using the automatic synchronizer all possibility of injuring the rotary converters is eliminated.

When accidents occur which shut down entirely one or all of the substations, it is very important to be able to start up all the machines and get the system in operation

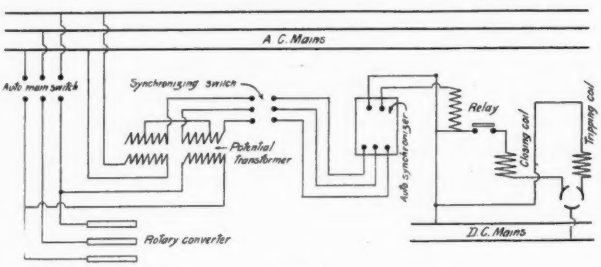


Fig. 4

with the least possible delay, and by using the automatic synchronizer the only thing necessary for the attendant to do would be to throw in all the starting motor switches and leave the rest to the automatic synchronizer.

The primary object of the after-cooler, which is used in connection with modern air compressor plants, is to dry the air after leaving the compressor by cooling it to a point at which the moisture will be condensed, so as to be withdrawn from the system, This assures the delivery of dry air to the tools or appliance, using the air and prevents them freezing up at exhaust. Aftercoolers prevent the accumulation of water in the pipe line, and the cold air which they furnish relieves the pipes from the strains of expansion and contraction due to great difference of temperatures. Lubrication of pneumatic tools is also aided by using dry air, as dry air does not wash out the lubricant as wet air does.

GETTING READY FOR THE EXAMINER

By A. C. Waldron.

The following are some questions which were asked me in eleven different examinations which I took from one of the most severe inspectors in the State of Massachusetts, including all grades of licenses from fireman's license to the first-class unlimited engineer's license with gold seal. I will also add my own answers to these questions:

1. How much lap would you put on a Putnam engine? *Ans.* The Putnam engine has poppet valves, consequently no lap can be given.

2. How do you get equal leads with equal cut-offs on the Putnam engine? *Ans.* On account of the angularity of the connecting rod, the crank end will cut off earlier; therefore, loosen the set-nut and taper pin on the cam-lever shaft and draw the cam-lever bell-crank away from cylinder, which will increase the time the valve is kept open, and will give later cut-off. In some engines there is an eccentric pin in the cam-lever bell-crank, which will answer the same purpose; but raise the governor high, so as to be sure that it does not lift the valves and cause it to race on light loads.

3. The inspector said he went to a certain town to inspect a boiler where there was a 10 horse-power electric motor running the power. Beside it was a 35 horse-power slide-valve steam engine, which would not do the work. He took the engine apart, and saw the reason. The examiner here gives dimensions and port openings all in a hurry, and asks for two reasons why the engine won't do the work. *Ans.* I gave him three answers: First, put on an eccentric with greater throw; second, put on a rocker arm which will increase the throw; third, take off the lap on the valve. The trouble was too much lap and too advanced eccentric, so that the port opening was very small.

4. Which valve is liable to slam on cross-compound engines, and how would you remedy it? *Ans.* The high-pressure valves will slam on light load because the steam expands below the receiver pressure at that particular time, and the receiver pressure, being greater, raises the exhaust valve. To remedy this, lengthen low-pressure cut-off, which will lower the receiver pressure.

5. How much faster does the cam-shaft run than the crank-shaft on a Putnam engine? *Ans.* It does not run so fast; it runs one turn for two revolutions of the crank-shaft.

6. What would you do if you expected an extra heavy load while running a Green or Corliss engine? *Ans.* I would put the safety pin in on the Corliss engine, or throw the governor collar around on the Green engine, so that the governor in lowering would not cut the engine out by bringing the safety stops in play. Be sure, however, not to leave the engine in this condition, because, if the governor belt breaks, the engine will race.

7. Why don't a Putnam engine have dash-pots, and what closes the valves? *Ans.* It is the unequal area of the poppet valves. The top one is somewhat larger than the bottom one. This, together with the spring and positive closing device on the valve stem, closes the valve.

8. What will make a duplex pump stop. *Ans.* If by some means the lost motion of the valves was taken up, caused by something getting in between the nut and valve-ears, it would stop.

9. Suppose someone should put a half-inch lap on your Corliss valves, what would you have to do to run with it; also, what effect would it have on the other parts? *Ans.* The eccentric should be moved ahead, which would make compression very great, unless the exhaust rods were changed. The release would be very early, and the range of the cut-off would be limited.

10. Is there any difference in shaft governors? *Ans.* Yes. As a rule, shaft governors change the lead and compression with every change of load; but the Fitchburg and Buckeye governors only change the cut-off, the compression being fixed. To find if a shaft governor changes its lead, take hold of the weights and pull them out; if the valve moves, it has a variable lead.

11. How would you tell if the surface condenser was leaking? *Ans.* Take some water of condensation from the hot well and fill a glass half full; put in a drop or two of "silver nitrate," and if you are using sea water for condensing purposes, it will turn white in the glass.

12. How do you tell from the indicator card if the engine is leaking? *Ans.* The expansion line will be convexed if the exhaust valves do not leak, but if they do, it will lose its convex form.

13. Why is it that some engines will run with a light load when linked up to mid-gear with a link motion? *Ans.* It is because the link motion is of the open-rod style, which increases the lead with short cut-offs; consequently, it will run on the lead when in mid-gear, which would not happen with cross rods, as the lead decreases with short cut-offs.

14. Where does the 33,000 foot pounds come from? *Ans.* According to Watt, the average traveling rate of a horse drawing a sulky was 5 miles an hour, or 440 feet per minute, and a spring scale would show that the horse was exerting a pull of 75 pounds, or $75 \times 440 = 33{,}000$ foot pounds, or one horse-power.

15. How do you give the low-pressure cylinder on a tandem compound engine more lead? *Ans.* Change the low-pressure steam roads and dash-pot rods.

16. If you had a cross-compound engine overloaded, how would you get along? *Ans.* By letting in live steam to the receiver and getting more work out of the low-pressure cylinder.

17. Where are butt-straps on boilers caulked? *Ans.* On the outside, because it will not spring the plate, and because the inside strap is much wider and strengthens the plate more.

18. How much space will a ton of coal take up? *Ans.* A cubic foot of coal weighs about 53 pounds, and requires about 43 cubic feet of space to stow away a ton.

19. In quadruple riveted joints, how many rivets are in double sheer, and how many in single shear? *Ans.* There are 8 rivets in double sheer and 3 in single shear.

Power Plant of the Scotia, Pa. Ore Washers Destroyed by Fire

One of the largest and most modern mining power plants in Pennsylvania was recently destroyed by fire. The plant was located at Scotia, Pa., and included the extensive ore washers of the Bellefonte Furnace Company, formerly operated by the Carnegie Steel Company, of Pittsburg. One hour and fifteen minutes after the fire started in the oil room the building was a mass of smouldering ruins. In this building there were two Atlas engines, 40 and 80 horse-power; three Buckeye automatic engines, of 70 horse-power each; three small slide-valve engines, of 30 horse-power each, and machinery which handled all the stock that two steam shovels could load, the daily output of the washers being 200 tons of ore, running 45 per cent. iron. The ore mined at this plant is of the brown hemitite, and is found in pockets. The general nature of the ground is sandy loam; the ore deposits sometimes intermingle with it. The depth is in some places 200 feet below the surface. The soil is mined and hauled to the washers, from which the ore is washed. The deeper the deposit, the richer in iron the ore is. There are ten sets of elevators, two in the washer and eight in the jig house; also two large conveyors and one short one. One of the large conveyors carried the ore from the washers to the main line of elevators. These elevators lifted the ore and discharged it in the separating screen of the jig house, which separated the different sizes of ore for the fine and coarse jigs, where, after the light ore and flint was taken, there were five elevators that lifted the ore again and discharged it on the other large conveyor. This conveyor carried the ore to a small tank, from which it was loaded in small cars, these cars being hoisted on a small plane and dumped in the large railroad cars. The flint from the jig house was

Ruins of the Scotia, Pa., Ore Washer Power Plant

elevated to another small tank, and thence loaded in a small dump car and hauled away from the building.

The buildings that were saved were the machine shop, in which were a lathe, planer, and drill press, also two blacksmith forges and one steam hammer, and the boiler house, which contained six horizontal return flue boilers, from 25 to 30 horse-power; one double-acting pump for feeding the boilers, one open heater, and one Berryman closed heater, the open heater being used simply as a supply tank for the feed pump. Two artesian wells supply the water for washing the ore and the boilers. These wells are run by a 70 horse-power Buckeye engine. One other well supplies the water for domestic purposes, and is a general supply for the families who live at the place. These wells are from 380 to 450 feet deep.

The stock or material to be washed was dug and loaded in 1¼-yard cars in the mines by two steam shovels, the tank being an open one, and hauled to the foot of a 700-foot plane, from where it was hoisted by the 40 horse-power Atlas engine to the tipple, which was about 45 feet above the surface of the ground. These tipples were of the revolving type, turning the cars upside down. There were three tracks on this plane; the two outside ones were for the loaded cars, the centre one for the empties. In hoisting a draught of loaded cars on the one side, a tail rope hauled the hoisting rope back on the other side for a draught on that side. The empty cars were let down by a small ¾-inch rope, called the monkey rope, on which a dummy was attached.

This plane has been in operation since 1883, having frequently been remodeled until it reached its present dimensions. The total loss is estimated at $35,000, but in counting the cost of the labor to rebuild this plant and to replace the machinery just as it was before the fire, it could not be done for less than $70,000, as this was the largest and most modern in the State of Pennsylvania, situated at the terminus of the southern end of the L. and T. branch in Centre County, Pa., about twenty-five miles from Tyrone, Pa.

EXPLOSION OF AN ECONOMIZER

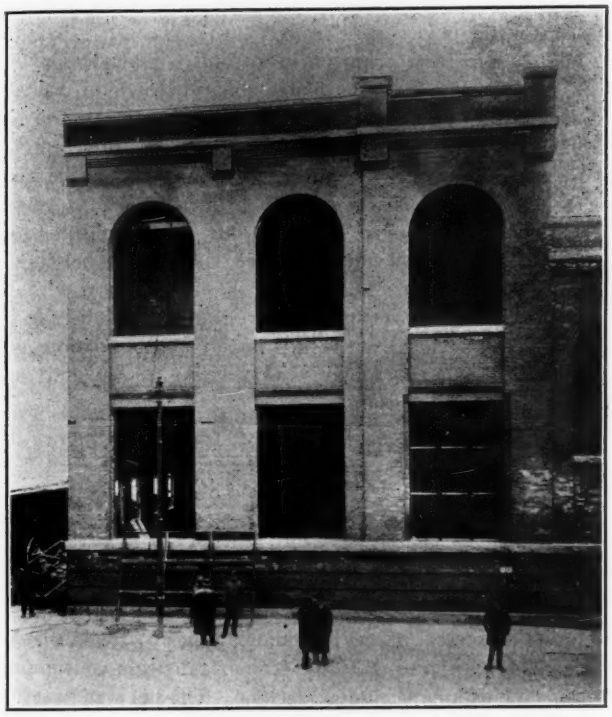
Power Plant of the Hamilton Manufacturing Company. Lowell, Mass., Partially Destroyed

Fourteen men were injured, two fatally, by an explosion of an economizer attached to the boilers in the new 3000 horse-power plant of the Hamilton Manufacturing Company, Lowell, Mass. The explosion occurred about 8 o'clock on the morning of February 19th, and besides injuring the men who were working about the plant, it badly damaged the boiler room and a number of surrounding stores.

When the explosion came there were about 30 men engaged in different kinds of work around the building, which was a new two-story building near completion. It was still in the hands of the contractor, who was installing the machinery of the plant, and for that reason there were more men engaged around the plant than there would have been ordinarily. Th men employed on the stagings were thrown to the floor, those who were on the floor were thrown off their feet, and the building was filled with escaping steam. There was no warning before the explosion. Suddenly there was a deafening roar, and a rumbling sound followed the roar similar to an earthquake. Every window and door of the boiler room was blown out, some many feet in different directions; steam pipes were broken, and electric light wires torn from their fastenings. The explosion was heard a long distance, and the pieces of wood that were hurled in every direction broke six large plate-glass windows in business houses across the street. A big window at the end of the boiler room was blown through the front of one store.

The economizer that exploded was the middle one of three that were in the plant. It was 60 feet long, 10 feet high, and

contained 720 tubes. It had been in operation several weeks, heating the feed water on its way to the boiler. The pressure carried on the boilers was 175 pounds, and the force of the explosion of the economizer seemed to be at the top, there being a hole in the roof above where the economizer stood.



Result of an Economizer Explosion at the Plant of Hamilton Mfg. Co , Lowell, Mass.

No explanation of the explosion has yet been officially made public, but it is generally stated that it was the presence of unburned gases that caused the trouble. The men who were working in the boiler room, however, said that they could not help noticing something strange before the economizer exploded. They claimed that for an hour before the temperature in the boiler room was extremely high, and that a whistle was heard about the time of the explosion, which, it was thought, was due to either high or low water.

As a result of the explosion it was necessary to close the entire plant, more than 1800 operatives being thrown out of work.

———o———

Large Ventilating Fans.

Ventilation of the tunnel through which trains reach and depart from a new Union Terminal at Washington, D. C., has been accomplished along lines and by methods that make the installation of especial interest. The problem was that of removing from the tunnel all trace of gas and smoke left by one passing train before another train should enter the tunnel. This called for a high output of air, although the circumstances were such that the ventilating apparatus must be confined to a very small space and attain high efficiency at low expenditure of power.

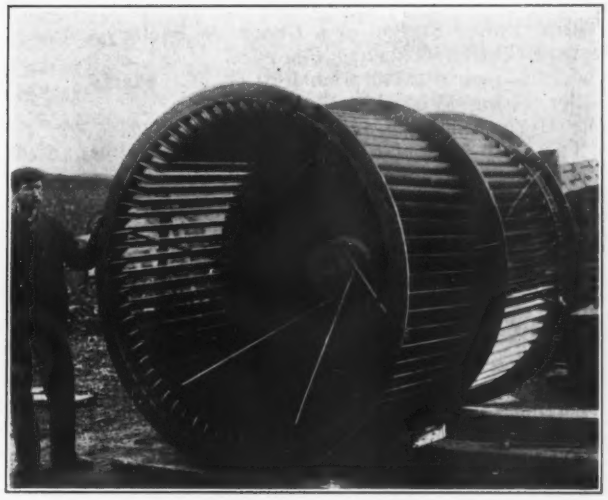
At a point about 300 feet from the terminal portal were constructed two ventilating ducts, each about 5 feet wide, which are carried along both side walls of the tunnel to the full height of about 18 feet, with a cross duct under the tracks. The space available for the fans on which was imposed the duty of clearing the tunnel of smoke in a few minutes' time, was 18 feet high by 13 feet in width. In this space it was necessary that the fans and casings should be erected.

The specifications imposed by the Pennsylvania Railroad Company called for two fans 120 inches in diameter, each capable of delivering 260,000 cubic feet of air per minute against a 1½ inch water gauge. The speed was not to exceed 145 revolutions and the power requirement was limited to 120 horse-power.

The fans installed are of the Sirocco design, with double inlets corresponding in dimensions, efficiency, speed and power requirement to the specifications just noted. These fans, driven by electric motors, have now been in use for several weeks, and have satisfactorily performed the duty imposed upon them.

Fans of this design are used in a number of large office buildings, and aboard the latest vessels of the British Navy, the White Star Line, Cunard Line, Hamburg-American Line, American Line, and others, where the requirement is for high output in connection with limited space.

Chief among the departures in design noted in the fans installed in the Washington terminal tunnel, are the shape, size and number of the blades. It has been found that in all diameters the best results are obtained from 64 blades. It will also



Double Inlet Centrifugal Fan, Output 260,000 Cubic Feet Per Minute

be noticed that the blades are very short radially, being only one-sixteenth of the diameter of the fan. Axially, however, the blades are unusually long, three-fifths of the diameter.

The outer edges of the blades are bent forward to a set angle in the direction of rotation, and are very slightly cupped. The inlet and outlet of the fans are practically equal to the area of the fan itself. The special advantage of the size and shape of the blades is that power-absorbing eddies are almost entirely eliminated and the velocity of the air so greatly accelerated that it actually exceeds the peripheral speed of the blades by as much as 70 per cent. The intake draft of the fan shows practically no variation over its entire area.

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GREETING:

With this issue THE PRACTICAL ENGINEER passes into control of the Technical Publishing Co., and the May issue will be published from 355 Dearborn Street, Chicago. The reading pages will be increased in number, new departments will be added, additional writers secured, and no expense or effort spared to make it more than ever THE paper for those working in the power plant field.

We feel sure that engineers want and will gladly pay for a $1 paper which contains many dollars' worth of valuable information. With the May number THE PRACTICAL ENGINEER will be made a $1 paper; but, until July, 1908, a two-years' subscription, either new or renewal, will be given for $1; after July the subscription price will be $1 a year.

Past work has proved that the staff, which in the future as heretofore, will devote its entire energies to helping all power plant interests, knows and is in sympathy with the needs of the field. We pledge our heartiest devotion to the work of meeting those needs, and hope that our relations with readers and advertisers may always be as cordial and satisfactory as they have been.

E. R. SHAW, *President,*
ARTHUR L. RICE, *Managing Editor,*
CHARLES S. CLARKE, *Secretary.*

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Steam Turbine Tests.

A few years ago, when the steam turbine first became a factor in central stations as a prime mover, the manufacturers of several of the best-known types of steam turbines made elaborate claims as to the economical steam consumption of this type of kinetic energy machine. The pot was kept boiling by the almost weekly publication of tests made upon some turbine erected in some plant, and, while no startling economies were shown by these tests, yet they purported to be reliable tests, showing fairly good operating efficiency when the turbine was new. During the last year, however, interest in these kind of tests have simmered down, and they would now almost be forgotten were it not for the fact that engineers representing the two largest manufacturers of radically different types of turbines, are throwing aspersions upon each other's tests, and they have shown inconsistencies in each other's figures which make the onlooker sit up and take notice.

One of these controversies is taking place between J. R. Bibbins, of the Westinghouse Company, and W. L. R. Emmet, of the General Electric Company, in reference to the tests made upon 7500-kilowatt Parsons turbine at the Waterside Station of the New York Edison Company, and a 8000-kilowatt Curtis turbine in the Chicago Edison Station. According to Mr. Emmet's figures, with a 6000-kilowatt load on both turbines, the 7500-kilowatt Parsons turbine showed a steam consumption of 17.25 pounds of steam per horse-power per hour, while the steam consumption of the Curtis turbine was 15.3 pounds of steam per kilowatt hour. According to these same figures, at 8000 kilowatts load, the Parsons turbine showed a steam consumption of 16.6 pounds of steam per kilowatt hour, while the Curtis turbine showed an economy of 15.1 pounds of steam per kilowatt hour, all figures being reduced to the same condition of 177 pounds gauge pressure, vacuum 27.3 inches, and superheat 96 degrees Fahrenheit. According to another comparison, where the conditions of the Parsons turbine are re-

duced to those of the Chicago operating conditions—namely, steam pressure 180 pounds, vacuum 29 inches, and superheat 125 degrees—the Parsons turbine showed an economy of 16.1 pounds per kilowatt hour, and the Curtis turbine an economy of 13.3 pounds under a load of 6000 kilowatts. Under the same conditions, with the load 8000 kilowatts, the Parsons turbine showed a consumption of 15.3 pounds per kilowatt hour, and the Curtis turbine about 13 pounds.

Commenting upon the results of these tests, Mr. J. R. Bibbins says that the results of the tests shown upon the Curtis turbine are inconsistent and irrational, and that, based upon the New York conditions under which the Parsons turbines operated—namely, 177 pounds steam pressure, 27.3 inches vacuum, and 96 degrees superheat, with 9865 kilowatt load—the Parsons turbine showed an economy of 15.08 pounds per kilowatt hour, and the Curtis turbine 16.05 pounds per kilowatt hour, or a 6½ per cent. efficiency in favor of the Parsons turbine, whereas Mr. Emmet's result would have one believe that the Parsons turbine occupied a very humble place in its relative ability to transform steam into kilowatts.

Some of the discrepancy in the results seem to be based upon a difference of vacuum under which the two tests were made. The Curtis type of turbine, according to these tests, seems to give its greatest economy under high vacuum, and Mr. Bibbins, speaking of Mr. Emmet's figures, says: "We cannot allow him to find refuge in the ethereal joys of 29.5 inches vacuum either as a standard operating condition or a basis for commercial testing. In fact, he himself admits as much in the statement that at Chicago the vacuum only 'sometimes' reaches 29.5 inches. This, to be sure, is fair condenser performance with 32 degrees water, but hardly to be considered as a normal operating condition in present turbine practice. Notwithstanding, we are treated to a delectable series of tests under these particular conditions as a characteristic measure of Curtis turbine efficiency. . . . I cannot help but feel that this entire subject of the effect of operating conditions on turbine economy, and of the commercial considerations arising therefrom, is at present in an exceedingly muddled state."

This latter remark sounds very good to the ears of the operating engineer, who has always been led to believe, from the advocates of the steam turbine, that the installation of a steam turbine was a panacea for all financial operating ills, although the coal bill may speak otherwise; but when experts who represent the acme of turbine intelligence in this country disagree as to the economy of a plant under given conditions, how can the average engineer know where he stands when discusing the subject?

Operating engineers who have charge of steam turbines have always had a sneaky notion that the amount of coal necessary to run a turbine was as much in excess of that shown by the tests which were made upon it, and they have often had to scratch their heads when comparing coal bills with the kilowatt meter. This discrepancy in itself would not be so bad had not the owner been led to believe that his plant should show a certain economy, and when operating expenses for a period of time are calculated, the engineer is called to the front to explain the apparent uneconomical operation of the plant.

While it is undoubtedly true that a turbine gives considerable economy when operating under ideal conditions of vacuum, yet there are very few plants which carry a vacuum above 29 inches all the year around; in fact, an engineer usually points with pride to his vacuum gauge when it is registering as high as 28 inches, and vacuum less than 28 inches is more common below that value than above it.

It is all right to state the concrete fact that an increase of one-inch vacuum from 28 to 29 inches quadruples the kinetic energy in the steam, but what the turbine user is most interested in is not what the turbine will do under the best conditions, but what it will do under conditions as they exist in practice.

While the turbo-alternator has always had very many advantages, such as parallel operation, governing and capacities for overloads, it has been more handicapped than otherwise by experimenters and testers who have "hitched their wagon to a star," and who have overloaded plants with condensing apparatus, in order that the turbine shall show a low consumption of steam per kilowatt hour, regardless of the expense incurred throughout the other part of the plant.

If less emphasis was put upon abnormal tests of the turbine and more upon actual operation as found in practice, it would be better for the steam turbine manufacturer, the steam turbine owner, and the operating engineer.

Single-Phase Electric Railways.

The total number of single-phase electric railways in operation and in course of construction in this country is 28. The total mileage is 966.3, which is simply the length of the road, and does not take into account the fact that some roads may have two, three or four tracks electrified. Of this total mileage, roads with 691.8 miles are in electric operation and roads with 274.5 miles under construction. The total number of motor cars is 240. The total number of locomotives is 57, the total horse-power of motors employed is 137,400. The longest single-phase road is that of the Indianapolis and Cincinnati Traction Company (116 miles), but the Spokane and Inland Railway Company (115 miles) is a close second. The line voltage is 1200 on one road, 2200 on two roads, 3300 on ten roads, 6600 on eleven roads, and 11,000 on four roads. The frequency is 25, with two exceptions: The Visalia Electric Railway Company uses a frequency of 15, and the Shawinigan Railway Company 30-15. On thirteen roads both single-phase and direct-current systems are used. All of the roads are operated from a single catenary trolley, with the exception of the New Haven road, which uses the double catenary line construction.

A Message from Alaska.

I received my first number of THE PRACTICAL ENGINEER, and I am very much pleased with it. I have shown it to some of my engineer friends here, and the paper goes like hot cakes. Every engineer I have shown it to digs up his four bits (50 cents). I am enclosing 16 subscribers, and expect to send as many more. It is hard to get second-class mail here, so send my premiums by first-class registered mail, as the post-office is closed for second-class matter from October until May.

We are having a fine winter, but we are having a lot of trouble with the miners about the strike. The town of Fairbanks is under martial law, and the soldiers are coming up the river over the ice, so there is some chance of seeing some fun before spring.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

The Effect of Hollow-End Plungers.

EDITOR THE PRACTICAL ENGINEER:

In answer to J. C. H., as to hollow-end plungers, I suppose, from its action, as stated by him, that the pump is the Deane vertical; otherwise the hollow plunger will in no way interfere with the working of the pump. In a vertical pump, any space which might be opened from the lower part of the plunger would contain air, and, in forcing the water from the pump cylinder, this air would be compressed until it was equal to the pressure in the boiler, or any pressure against which the pump might be working.

When the plunger is reversed and the outer valve closes, the air will expand at atmospheric pressure before the plunger will lift any water. It will act the same with a head of water for supply until the head water is of sufficient height to equal the pressure against which the pump has to work, although its pumping qualities will increase in proportion to the increase in height of head water. It would not be as J. C. H. supposes, in that the air space would expand and prevent a vacuum, because, should the air expand, its tendency would be to create a vacuum, the same as would be the tendency at the end of a solid plunger. It, of course, does expand, but only to the extent that it was compressed.

If a plunger works in a horizontal position, the open-end plunger has no effect whatever on the working of the pump. There is, then, no more reason for an air space being formed in the cavity than there is for the same to be formed on the end of a solid plunger at each suction stroke. If it is a vertical pump, the plungers have solid ends for a purpose, and the open ones cannot work satisfactorily.

North Bend, Neb. G. G. McV.

Sinking Float Cured with Graphite Coating.

EDITOR THE PRACTICAL ENGINEER:

In float or "pot" steam traps in which the discharge is operated by a hollow float made of metal the partial filling and sinking of the float sometimes occurs. In such cases the trap is put out of commission, the seriousness of which depends on circumstances, which may, under certain conditions, be of considerable importance. In many of these cases it seems certain that the water penetrates through the pores of the metal, which are too small to call leaks, in the ordinary meaning of that word.

In one particular case, a trap of this type was draining coils in which the pressure was held regularly at five pounds by a reducing valve. The float in this trap would sink with tolerable regularity about every three weeks, so it occurred to me that some kind of a coat of paint might do some good, if it was of such character that would stand the temperature and the effect of water.

The trap was used through the sugar season, which lasted only about three months each year. Before each season commenced the float was treated to several coats of graphite rubbed well in, a little boiled linseed oil being used to start the adhesion of the graphite. The float was made of smooth copper, and rather hard to treat, but all the coats of graphite which were put on hardly made any perceptible difference in the thickness of the coat. During my observation of the trap, it ran several years, and never sank again.

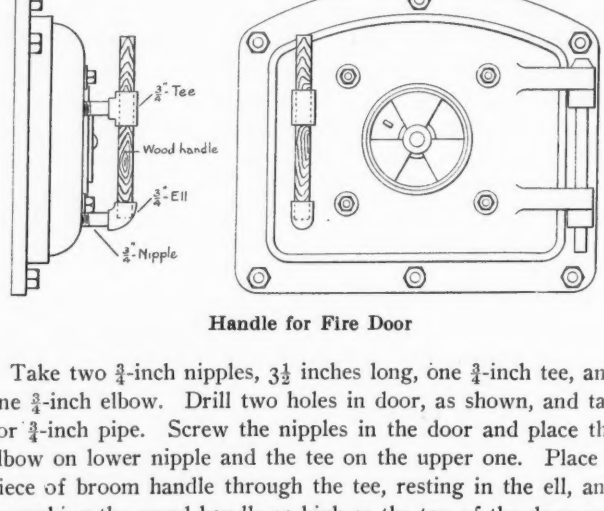
While it must not be thought that all floats will sink, there are none which may not sink so that such a treatment, which is little trouble, may be of considerable value.

New Orleans, La. J. O. F.

Handle for Fire Door.

EDITOR THE PRACTICAL ENGINEER:

I have been employed for some time as engineer in the State of Illinois, and in most places I have found the handles on fire doors to consist of a small hook, which becomes very hot and has to be opened by the shovel. When this hook breaks off, a bolt is sometimes inserted in its place, which is just as bad. I give here the details of a door handle which remains cool, so that it can be handled with the bare hand. It costs but a few cents, and takes about thirty minutes' time to put on.



Handle for Fire Door

Take two ¾-inch nipples, 3½ inches long, one ¾-inch tee, and one ¾-inch elbow. Drill two holes in door, as shown, and tap for ¾-inch pipe. Screw the nipples in the door and place the elbow on lower nipple and the tee on the upper one. Place a piece of broom handle through the tee, resting in the ell, and by making the wood handle as high as the top of the door you do not have to stoop to open door.

Joliet, Ill. J. B.

Desk Fan Used to Increase Boiler Capacity.

EDITOR THE PRACTICAL ENGINEER:

During a recent visit to a brother engineer I was introduced to a new and novel way to increase the draught through the furnace of a steam boiler. The boiler was a 42-inch return tubular boiler, the steam being used for heating the building and for cooking in a restaurant. Natural draught had fulfilled the requirements in the summer-time, but when the weather became cold the boiler would not furnish the necessary

amount of steam. A 12-inch variable speed desk fan was connected to the lighting circuit and placed in the doorway of the ash pit, and since that fan was started there has never been any trouble in making that boiler furnish plenty of steam.

Cambridge, Mass. T. A. R.

Setting Valves with Link Motion.

EDITOR THE PRACTICAL ENGINEER:

As there are many questions asked about valve setting with two eccentrics, I will try and explain a few points in reference to this subject.

To go about setting a link valve motion, adjust every part of valve motion by tramming the fly-wheel to find the dead centre of the crank-pin and tram the valve stem to get port openings of the valve. When the blocks are in full gear, the extreme travel of the valve is equal to the eccentric throw. With a horizontal engine, particular notice should be taken to see that the go-ahead rod is connected to the top of the link and the back-up eccentric to the bottom of the link, that the link is plumb and that the valve is centered over the ports.

To set the valve, put the reverse lever in the last forward notch, put the crank pin on the forward dead center and assuming that the lead is to be $\frac{1}{8}$ inch, move the forward eccentric ahead until the tram fits the mark on the stem corresponding to the port mark. Tighten the eccentric. Move the lever to the last notch on the reverse and move the fly wheel over the centre and bring it ahead again to the centre so as to take up the lost motion. Move the backing eccentric until the tram fits the lead mark again, and when the lead is the same for the back and go-ahead eccentrics, the setting is right.

The blind of a valve is the lap it has. If when the engine is on dead centre it is found that the eccentric blades are too long, they will have to be shortened one-half the blind, or until the tram fits the opening marks on the valve rod. If then the engine is moved to the other dead center but the engine has lost its lead, advance the eccentric $\frac{1}{8}$ inch for the required lead. Do the same for the other eccentric and the engine valves shoould be adjusted properly.

Orange, N. J. S. J. K.

Battery Cells for Hard Service.

EDITOR THE PRACTICAL ENGINEER:

In regards to the request of H. H. Y. for a battery that will require less frequent charging than the one he now has installed, I would advise that he look over his wires and test them for possible grounds or it may be that the cells are polarized, either of which would cause the trouble he mentions.

Taking it for granted that the cells are of the kind commonly used on small bell circuits, with a round carbon cylinder and a zinc pencil, with sal-ammoniac and water as the electrolyte, it will be found that after considerable service, the manganese-oxide, which is incorporated in the carbon cylinder for the purpose of attacking the harmful hydrogen and combining with it to form water thus prevent polarization, becomes exhausted and unless the carbon is made fit for service again by either heating over a bunsen burner or by being laid away for a considerable time, it will act as H. H. Y.'s batteries do and they will require frequent charging.

A type of cell that is a great improvement over the zinc pencil cell consists of having the carbon cylinder being fluted, and the zinc instead of having the usual pencil form, is made into a hollow cylinder outside of and very close to the carbon cylinder.

The carbon cylinder with pencil zincs is perfectly satisfactory for small installations, where the service is light, but where signals are made with great frequency, the cylindrical type will give first class service.

Charlestown, Mass. T. O.

Remedy for Boiler Trouble.

EDITOR THE PRACTICAL ENGINEER:

When running a boiler with forced draft, there is sometimes a great deal of trouble experienced, which is invariably either blamed on the fireman or on the system, but when the true

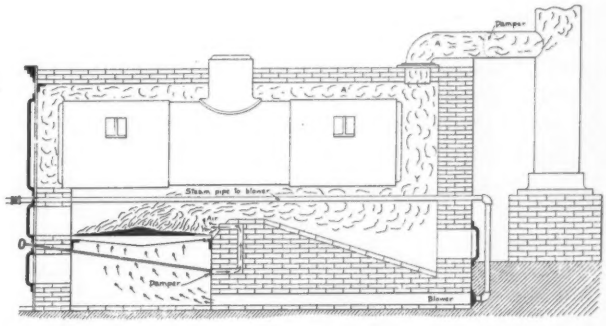


Fig. 1

cause is found, it may not be the fault of either. A faulty construction of the boiler setting may be the cause of it. I had an experience of this kind a short time ago. The boiler had been running for years with the Parsons draft system, but when pushed to the full capacity, trouble was experienced, although the engineer was a first-class man and up-to-date in the firing line. The boiler was one of three, of 80 horse-power each. Two of the boilers were connected to a brick stack while the one with which we had difficulty was connected to an iron stack 30-inch diameter and 60 feet high.

At times when the load was heaviest, this boiler would

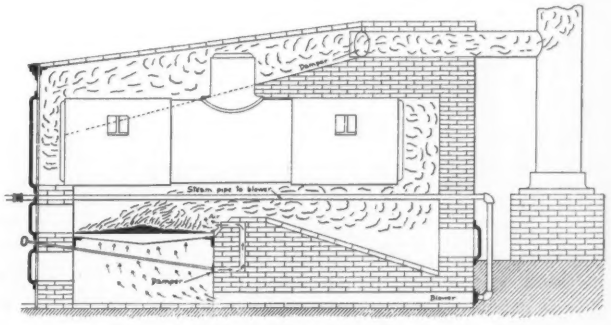


Fig 2

collect gases enough to blow open the furnace doors and the stack would get red hot for some distance above the roof of the boiler room. This naturally gave a great deal of trouble and anxiety to the manager and engineer, although there apparently was no cause for it. I was called in as consulting engineer and found that the flue and breeching was built as

shown in Fig. 1. After investigation with another consulting engineer, we found that the gases in the back arch Y exploded in the arch instead of going up the flue. A large amount of heat being generated at that point caused the stack to get red hot, causing the efficiency of the boiler to be decreased perhaps 25 per cent.

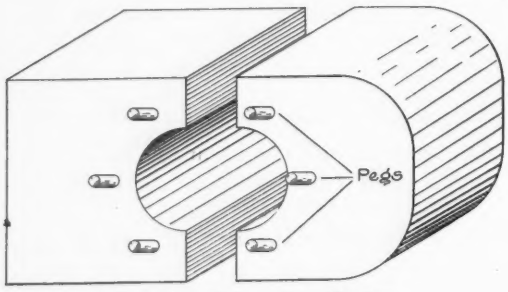
We found that the flue and breeching as shown at AA in Fig. 1 did not have area enough so we changed it to the arrangement shown in Fig. 2. With this arrangement, the boiler is doing good work and the boiler doors do not blow open and burn the fireman's hair off.

Orange, N. J. S. J. K.

Pegs in Boxes Cured Side-Slap.

EDITOR THE PRACTICAL ENGINEER:

I want to unburden my mind of a little trouble I had in trying to stop a wicked pound on my Corliss engine connecting rod, and which took me a long time to find. I took up the boxes very tight and let them out very loose, but it pounded just the same. After various other experiments, I took a crow-



Pegs Cured Pound in Engine

bar, put it between the shaft and crosshead, and pried on it, and I found the trouble. The pound was due to a side-slap, and it slapped every time it went over. I then took out the boxes, placed three pegs in each, allowing them to stick out 1-32 inch, to take up the lost motion, and the trouble was remedied.

Fall River, Mass. W. S.

Piping for Warming Steam Cylinders.

EDITOR THE PRACTICAL ENGINEER:

I have been very much interested in several of the ideas in the "Letter" column of your valuable and highly instructive magazine during the past few months, but I would like to make a criticism of F. J. D.'s arrangements for warming an idle steam cylinder. There is no doubt in my mind that his little kink works all right to heat the cylinder, but I fear with the drains connected up as he has shown, that should he ever have any trouble with the boilers foaming or priming and if both cylinder drains leading to the one waste be opened, the pressure from one side of the cylinder would force the water or drips from that side to the other end of the cylinder, causing the piston to come in contact with it and probably loosen a connection or start a cylinder head. In other words, I would advocate that F. J. D. use two separate drains from each cylinder to the waste or sewer connection and as for warming the cylinder, it could be easily accomplished with a $\frac{3}{8}$-in. or $\frac{1}{2}$-in. by-pass was not being used and connected to sewer similar valves, one to drain the steam line of condensation when the by-pass was not being used and connected to sewer similar to the arrangement F. J. D. has shown.

Depew, N. Y. C. W. D.

Cutting Gauge Glasses.

EDITOR THE PRACTICAL ENGINEER:

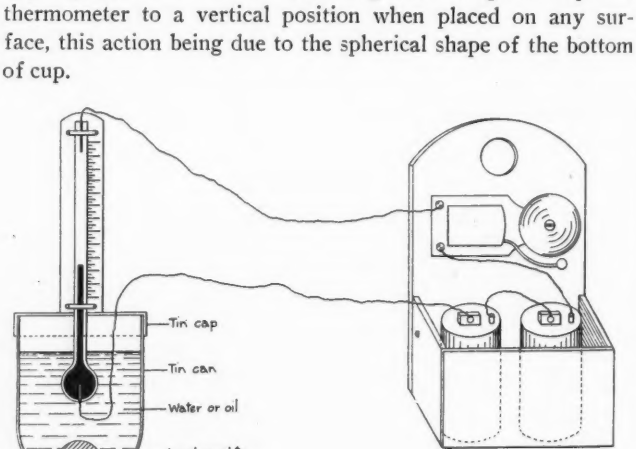
A simple and sure way to cut a water glass is to take a sulphur match and run it around on the inside of the glass to be cut. First wet the head of the match and then take another dry match and light it, holding it under that part of the glass where you have run the wet match. The glass will then snap off just as straight as the wet match was run around the interior of the glass. Cutting glasses with a file will ruin more than it will cut right.

Bordentown, N. J. B. F. H.

Hot-Box Alarm.

EDITOR THE PRACTICAL ENGINEER:

There is nothing which occupies an engineer's thoughts and keeps him from his duties more than a box which is inclined to heat. I have had trouble with them, and, to give some relief to my mind, I constructed a small device, as shown in the sketch, to give an alarm when the heat became enough to show danger. I secured a thermometer, such as is used on some incubators, which has a platinum wire fused in the bulb, and in the upper end I had a tinner make me a tin cup $1\frac{1}{2}$ inches in diameter and 3 inches deep. I trimmed the metal back of the thermometer so it would wedge into the cup, but left notches so it could only go a certain depth. I also trimmed all surplus metal from the top that was possible. In the bottom of the cup I placed lead of sufficient weight to bring the cup and thermometer to a vertical position when placed on any surface, this action being due to the spherical shape of the bottom of cup.



Hot Box Alarm

Using a cigar box, I made a container for two small batteries, such as are used in pocket flash-lights, and on it I mounted a small alarm bell. This box could be placed on a nail or hung from a wire or string or put on the floor. Connecting this with the two necessary wires, the instrument is ready for use.

When in use, place some liquid, such as water or oil, in the

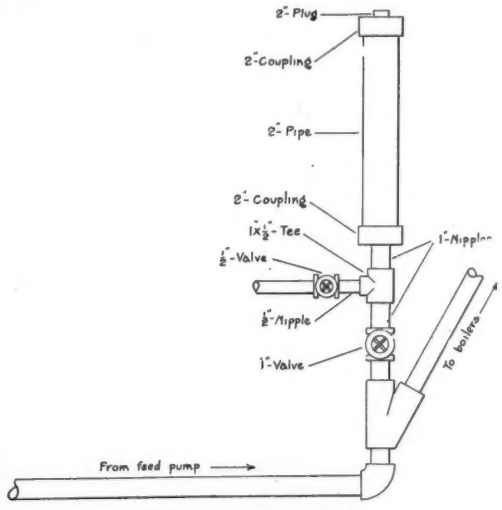
cup until it covers the bulb only. Place the cup on the part liable to become hot, and you have no worry about it until the bell rings.

North Bend, Nebr. G. W. McV.

Boiler Compound Feeder.

EDITOR THE PRACTICAL ENGINEER:

The accompanying illustration shows an effective and easily made device for the feeding of boiler compound continuously in small amounts, and one that I have never seen described, although the idea is not original with me.



Boiler Compound Feeder

To make it the following is required: Three 1-inch nipples, one 1-inch x 2-inch bushing, one 1-inch x ½-inch tee, one ½-inch x 3-inch nipple, one ½-inch angle valve, one 1-inch globe valve, one piece of 2-inch pipe about 3 feet long, two 2-inch couplings, and one 2-inch plug. These parts are assembled, as shown in the illustration, and located in any convenient place on the feed line where there is a suitable fitting.

To fill with compound, close the 1-inch valve, open ½-inch valve, and drain off water. Then remove the 2-inch plug, close ½-inch valve, and put in the compound, which may be either in liquid or dry form; replace plug, open 1-inch valve, and the compound will mix with the water and pass off to the boilers. By varying the opening of the 1-inch valve the rate of feeding can be changed, which, of course, will require experimenting.

I would advise using valves with renewable discs, as they may easily be repaired, and, while the above sizes are given for the fittings, any others may be used; but small valves are just as good and much cheaper than large ones. If pump is handling cold water, it would be advisable to locate feeder between the heater and boilers, as most boiler compounds mix better in hot water.

Trenton, N. J. H. H. Y.

Instructions for Firemen.

EDITOR THE PRACTICAL ENGINEER:

On entering the boiler room in the morning, before starting up, it is a good plan, before taking off your clothes, to look at the water levels and blow them down, to see if they show the same level. Do not break the banking unless you are sure the water level is correct. Do not have a dirty water glass on the boiler. If the glass is dirty put in a new one. The proper method for doing this is to first be sure that there are no small pieces of glass left in the valves or packing nuts. Put washers on the glass a size smaller than the glass, and when in place screw up the bottom gland first a little tighter than you can with your fingers, and be sure that the glass does not rest on the bottom. Then screw the top gland finger tight. It may leak a little at first, but it will stop when the glass gets hot and expands.

When opening the gauge valves, be sure that the pet cock is open at the bottom of column. Open the steam valve very slow, so as to heat the glass, and then open the water valve very slowly, and then close the pet cock. If the glands leak around a glass and need a little taking up, be sure to close both valves and open pet cock to prevent being injured from flying glass should it break.

Pressure should not be carried so high that the safety valve will sizzle all the time, but it should be kept several pounds below the pressure at which the valve is set. Blow off the safety valve once a day. In this way the valve may always be kept tight, safe and in good condition.

In feeding boilers it is a good plan to keep the water lever as near uniform as possible by having the pump or other feeding device running continuously, so that no more water will be fed than is being drawn from the boiler. Never pump cold water into a boiler when possible to avoid it.

In blowing down a boiler make it a practice to have the day fireman, when shutting down at night, fill the boilers to the top of the glass and let the night man, before he starts up the fires in the morning, blow the boilers down within a half inch of the bottom of the glass, as the water has remained still all night and the sediment has had a chance to settle to the bottom of the boiler. If you have a surface blow-off, use it at least once a day, or more if the water is muddy.

When opening or closing the blow-off valve always do it very slowly. When it is necessary to clean a boiler it should never be blown down under full steam pressure, but the boiler should be allowed to cool gradually until the pressure has almost or entirely disappeared, so that the water will practically run out by gravity. The back and front handhole plates and the manhole plate should be removed and the boiler washed out with a hose, first through the manhole and then through the front handhole, the blow-off being open to allow the dirty water to drain out. When the boiler is thoroughly washed a light may then be inserted to see if the boiler is thoroughly clean. When found to be in a satisfactory condition, the manhole and handhole plates should be looked after, to see that they are perfectly clean, so that they will make a good joint when replaced.

Before closing the boiler, however, scrape the end of the fusible plug, and be sure that the metal has not wasted away from the action of the water. Low water is not always the cause of the fusible plug giving away. Such an occasion enforces a shut-down, and the man in charge gets the credit for allowing the water to get low. As it is easier to lose a good reputation than to gain one, all practical precautions should be taken.

Two boilers under steam pressure should never be con-

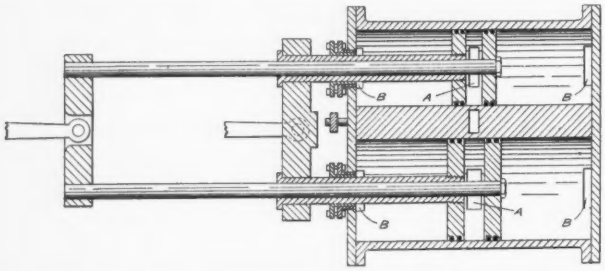
nected until it is reasonably certain that the pressures are the same, and even then the stop valve should be opened slowly. In the economical operation of a boiler, which is the hardest part of a fireman's work, there is no fixed rule to govern all boilers. Every fireman must study his own plant and find out for himself the best and most economical way of doing his work. The better the man he is, the quicker will he recognize the existing conditions in his plant and the proper method of operating it.

Fall River, Mass. H. M.

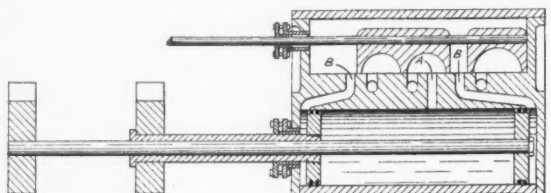
A New Type of Compound Engine.

EDITOR THE PRACTICAL ENGINEER:

An invention that will allow a compound engine to run compound or simple is shown in the accompanying illustration, and has recently been patented by me. A high-pres-



sure cylinder and a low-presure cylinder, as shown, has steam admitted between the pistons at A and at the ends, BB. If cylinder heads are blown out, the valves can be closed and the engine remain in operation. I have been told by mechanical engineers that it is the only design of a balanced compound engine for heavy loads. It is designed especially for us on locomotives, and the difference from



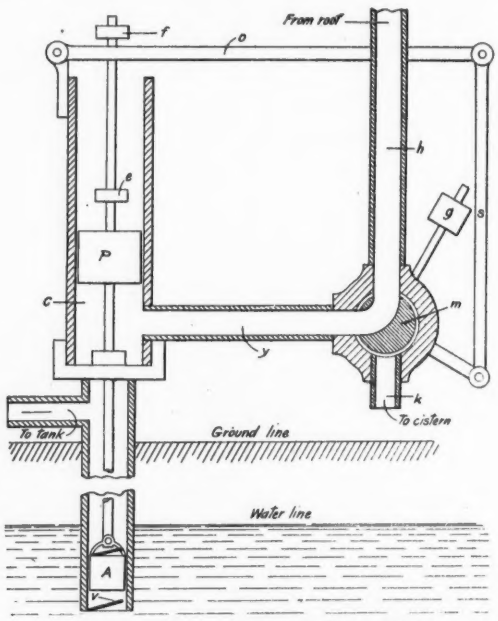
the usual construction can easily be seen. The two hollow pistons and the two solid pistons are connected to two cross heads, making a double-expansion engine, or practically four engines in one, which, when running, will give good balancing service for all parts of the revolution. The valve gear shows the methods in which steam is distributed.

Springfield, O. HARRY L. ANDERSON.

Rain Water Used for Pumping.

EDITOR THE PRACTICAL ENGINEER:

Why not make the rain water, as it descends from the roof, perform a little mission on its way to the cistern? By referring to the accompanying illustration, a device for such a purpose may be rigged as follows: In the pipe from the roof to the cistern, place a 3-way valve, as shown at *m* on which are fastened two levers, one for weight *g*, the other for rod *s*. Place the valve so that when the weight is on one side, as shown, it allows the water to flow from pipe *h* to cylinder *c*. Then as pipe *h* fills with rain water, it will cause pressure on piston P and will lift the pump plunger A and draw water through valve *v*. When plunger P is lifted so that the collar *e* lifts on



Arrangement for Utilizing Rain Water

lever *o*, the weight *g* will be thrown over center and valve *m* will close pipe *h* and open passage from cylinder *c* out through *k* to cistern, allowing plunger A and piston P to fall. When the collar *f* comes in contact with lever *o*, the valve *m* is again turned and the operation is repeated.

The capacity of the pump depends upon the amount of rain water falling; the faster the water falls the faster the pumps will work. The whole device may be made of a couple of old pump cylinders and some pipe fittings, with a pump plunger at the bottom. The valve can be made from any straight piston valve, by drilling and tapping in one side for the pipe *y*.

North Bend, Neb. G. M. V.

Strength of Hollow Shafts

EDITOR THE PRACTICAL ENGINEER:

With the increasing size of machinery, many new problems confront the engineer in the designing of the different parts. Every pound of metal must be made to count, yet strength must not be economized to save weight in any case. This often takes considerable skill, and when the result is accomplished the question often arises as whether the desired result has been attained. This is true of hollow shafts, which are more and more coming into use for transmitting power, and it is often wondered why the taking of such a large piece of metal from out of the center of the shaft makes it no weaker. In reality, it does make the shaft slightly weaker, but very little larger must the diameter of a hollow shaft be made in order to make it as strong as a solid one and at the same time be much lighter in weight.

Suppose, for example, we have a shaft 12 inches in diameter

with a 48-inch crank for a lever, and submit it to a twisting strain. The formula for the twisting strain is as follows:

$$P = SI \div l\ r$$

in which P = turning force in lbs.

S = shearing stress per square inch.

I = Polar moment of inertia = $3.1416\ D^4 \div 32$.

l = length of lever.

r = radius of shaft.

$P = 10{,}000 \times 2{,}040 \div 48 \times 6.$

$= 71{,}000$ pounds,

which is the greatest twisting moment that could be allowed on this shaft.

Now, if 6 inches be taken out of the center of the shaft, making it hollow, the shaft will stand

$$P = 10{,}000 \times 1{,}912 \div 48 \times 6 = 66{,}400 \text{ lbs.},$$

or the shaft has been weakened $71{,}000 - 66{,}400 = 4{,}600$ pounds, or about 15½ per cent. Suppose, however, that a shaft slightly larger in diameter be taken, say 12¼ inches, with a 6-inch hole through it. Then

$$P = 10{,}000 \times 2{,}094 \div 48 \times 6\tfrac{1}{8} = 73{,}000 \text{ lbs.},$$

which is somewhat stronger than the 12-inch solid shaft. If the shaft were 20 feet long, the 12-inch solid shaft would weigh about 7,690 pounds, whereas the hollow shaft will weigh only 6,180 pounds, nearly 20 per cent. lighter than the solid one.

The reason for all this becomes very apparent when we look at our formula and note how fast the turning strength increases as the diameter increases.

Letting P, S, l and r represent the same forces as before and since,

$I = 3.1416\ D^4 \div 32$ for solid shafts, and

$I = 3.1416\ (D^4 - d^4) \div 32$ for hollow shafts,

in which D is the outside diameter and d the inside diameter, and $r = D \div 2$, we have substituting in the formula,

$$P = SI \div l\ r$$

for solid shafts, $P = .1963\ SD^4 \div lD = .1963\ SD^3 \div l$

for hollow shafts, $P = .1963\ S \times (D^4 - d^4) \div l\ D$.

Hence in hollow shafts keeping S and l constant, it can be seen the available turning force increases as the cube of the diameter, so that it is little wonder that increasing the diameter ¼-inch makes so quickly for the strength taken out of the hollow core.

Combining the two formulæ, we find letting D = diameter of solid shaft and D_1 = diameter of hollow shaft, and d_1 = inside diameter of hollow shaft, that whenever $D^3 = (D_1^4 - d_1^4) \div D_1$, the hollow shaft is as strong as the solid one and much lighter.

H. H. B.

Joliet, Ill.

Experience the Best Teacher, Especially in Cases of Emergency.

EDITOR THE PRACTICAL ENGINEER:

When a man makes a mistake it is often caused by lack of experience, and generally occurs when doing a job for the first time. When such is the case, the mistake may be excusable. There are, however, many men, who should endeavor to exercise a little forethought so that they may not be guilty of blunders that could easily be avoided, and which count against them when it comes to building up a reputation as a first-class engineer. The following is a description of several instances which I think will serve to illustrate this fact.

An engineer that I knew, received orders to remove the plunger from a Worthington duplex pump, and after placing a socket wrench on the nut and a large pipe wrench on the shank of the socket wrench, called to the fireman to lend a hand, and both hung on to the wrench which, of course, was more than the rocker-arm could withstand, and it broke where the jaws engage with the crosshead, as shown in Fig 1. By this time some experience was gained and on the second plunger the fireman was instructed to hold the rod with another pipe wrench, while the engineer worked at the nut. As the engineer was now alone at this end, a piece of pipe was used to increase the leverage. This exerted considerable more power than the fireman could withstand, and at a sudden jerk this rocker-arm also broke. The next time he may have occasion to remove the plunger, he may have learned enough by his two previous experiences to block the wrench against the frame and thus be able to do the job alone, and without any damage. On another pump of the same make, an engineer undertook to pack the piston rod stuffing box, and left the nuts extending beyond the ends of the stud bolts. When the pump was started the cross-head brought up against the nuts and

Fig. 1

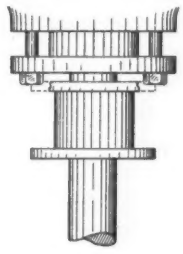


Fig. 2

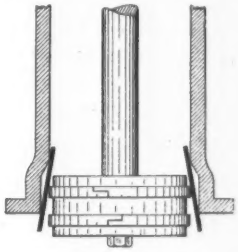


Fig. 3

broke off the flanges as shown in Fig. 2, putting the pump out of commission for a while. In this case the makers of the pump were party to blame for not allowing enough clearance, still a nut should not, under any circumstance, be left with the body only partly screwed in.

While trying to center a piston into a cylinder, an engineer once put some strips of sheet iron in the counterbore to make the rings enter. Not using any judgment, he forced them in too far, as shown in Fig 3, and then struck the piston with a heavy wooden block until he had it jammed so hard that he had to call for outside help to back it out and it is a wonder he did not split the cylinder. Another man on taking charge of a plant, got an idea his engine, a piston valve affair, was not cutting-off right, and started to remedy the trouble by adjusting the valve rod without taking any measurements or paying any attention to clearance. The result was, that on giving the engine steam the eccentric rod snapped off and considerable damage was done by the loose end falling into the basin for catching oil.

It is a peculiar fact that some engineers, upon taking charge of a plant, will take their time about inspecting the most important part of the plant, the boilers, but will not be satisfied until they have taken their engine apart and put it together again, no matter how nicely it may have

run. The writer once had charge of two high-speed engines, that had not been touched in eleven months, running every day in the week, and as smoothly as could be desired. A short time after my leaving this plant, there had been so much keying and adjusting of bearings that the engines were due for a thorough overhauling by a local machine shop.

On many of the larger pumps used for elevator service having twelve or sixteen-inch gate valves, these valves are often left-handed and are plainly marked on the wheel. One day a man going to work on a reserve pump of this kind opened both discharge and suction valves instead of closing them, and then started to remove one of the heads on the water end. Water from the pressure side was still automatically shut off by the pump valves in the upper deck, but of course there was a free flow for the suction water. A rubber gasket held the head to the cylinder after the nuts had been removed, and a hammer and chisel was used to pry the head loose. When it let go there was a miniature Niagara in the pump room. The engineer ran over and with a big monkey-wrench on the wheel, managed to twist off the valve stem in the excitement, trying to open it still further; probably with an idea that it could leak that much. The suction tank was soon empty, and operations could have been temporarily resumed by simply replacing the head and refilling the tank, and the true nature of the accident need not necessarily have been known in the office. Instead, a hurried call was sent to a nearby repair shop and the elevator service of a busy building was held up for an hour. The engineer who had just landed the job soon found himself looking for another, when the true state of affairs was found out by the office.

The above are simply a few incidents where a little forethought could have saved a lot of trouble and should not be construed as intended criticism against brother engineers. Experience is something that takes some of us a life-time to acquire and much can not be gained in a year or two. The lack of experience should, however, be rightly considered, but the practice of rushing ahead with a strange job without stopping for a moment to consider what the results are likely to be, cannot be too carefully avoided by men who take pride in their profession, and hope to make a success of it.

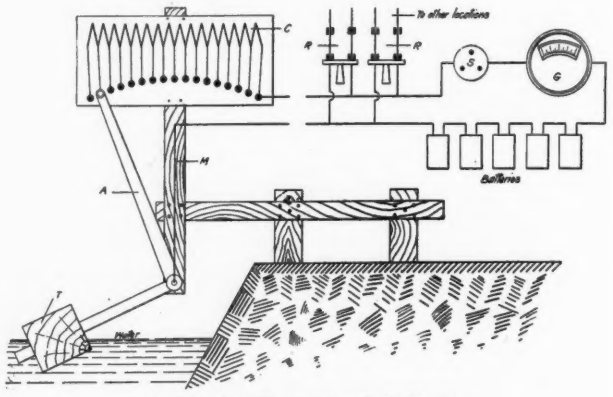
Chicago, Ill. R. C.

A Distant Water Level Indicator.

EDITOR THE PRACTICAL ENGINEER:

Where it is the duty of one person to take the measurement of water-heights in a number of locations along a river or body of water, the device, here shown, may be installed at a very moderate cost, and as many locations as are wanted may be connected to the same galvanometer and set of batteries.

The lever A is fulcrumed on a framework M so that when the float T, consisting of a block of wood. is raised or lowered by the water, the end of the lever A is swung around an arc of a circle and comes in connection with the different buttons, thus throwing in more or less resistance of the resistance coil C. When the height of water at any point is desired, a switch, S, is closed, letting the current pass through whatever amount of resistance coil there may be connected by the position of the lever and the galvanometer G will show, by the strength of the current, at what button the lever A stands.



A Distant Water Level Indicator

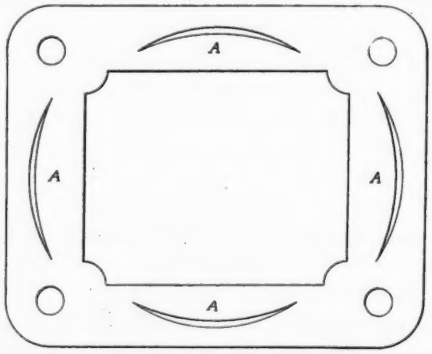
By experiment, the height of water in inches may be calculated by the graduated markings of the galvanometer and an accurate record can be kept of the variation of the water level at any desired point. By turning switches, R R, the level at other locations may be obtained, without extra expense except the cheap device at the water location and the necessary wires.

North Bend, Neb. G. M. V.

Method of Putting in Pump Gaskets.

EDITOR THE PRACTICAL ENGINEER:

There is perhaps no one thing among the innumerable minor happenings in a steam plant so annoying as the blowing out of a pump gasket. One of our duplex pumps, acting as a return pump, gives us a great deal of trouble in this respect. A rubber or lead gasket would not last twenty-four hours, so we tried placing a copper wire between two



gaskets (generally an effective cure for this kind of trouble), but met with poor success. While talking with our power station chief I mentioned our trouble and he gave me the following advice:

"Take off the cover of the discharge chamber and with a sharp tool make moon-shaped grooves, A A, between the

bolt-holes. Care must be taken not to have the grooves too near the holes, or trouble will result at this point. If the gasket still blows out, place a copper wire, not too large, in the groove."

Having tried this method, we can highly recommend it to all engineers having trouble of this sort.

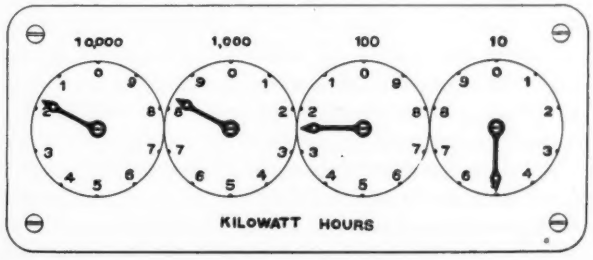
Leominister, Mass. A. D. P.

How to Read a Wattmeter.

EDITOR THE PRACTICAL ENGINEER:

Wattmeters, so called, are usually watt-hour meters, and record not the watts or kilowatts delivered by the machine, but the kilowatt hours which have passed through a given circuit. To get the distinction, it is necessary to examine the values of the different units. The watt measures the rate of doing work, or the rapidity with which work is done, and is equal to one ampere multiplied by one volt, or 1-746th of a horse-power.

If we wish to measure the amount of energy used, we must not only know the rate at which it is used, but also the time during which it has been used, and this gives us the unit of watt-hour or horse-power hour, the watt-hour being the energy delivered by a circuit when it furnishes power at the rate of one watt for a length of time equal to one hour, or it may furnish energy at the rate of two watts for ½ hour or three watts for 1-3 hour, the product of the watts by the hours giving the energy in watt-hours. The kilowatt is 1000 watts and the kilowatt-hour is 1000 watt-hours.



For a 16-candle power incandescent lamp, which takes ½ ampere at 110 volts, there will be used in one hour's time 55 watt-hours of energy, or .055 kilowatt-hours. The power expended in a circuit can be ascertained by multiplying the amperes of current flowing by the electro-motive force of the line.

On recording wattmeters, or, properly, watt-hour meters, dials are found like those on a gas or water meter. On lowest-reading dial, which is the one at the right hand, are measured usually kilowatt-hours, each division corresponding to the use of one kilowatt-hour of energy. The next dial to the left records 10's, the next 100's, the next 1000's, and so on. The reading is usually taken from left to right, the number on any dial being read as the smaller of the two numbers between which the pointer stands. As an example, take Fig. 1, in which case the lowest division is 10 kilowatt-hours. Starting with the left-hand dial, the pointer is between 1 and 2, so the reading is 1. For the next dial the reading is 8, for the next 2, and for the next 5, so that the whole reading will be 1825; but as the last dial reads 10's, the number of kilowatt-hours recorded is 18,250.

If a meter is not carefully adjusted, there is liable to be a lag in one or more of the pointers, and this is misleading and troublesome. When this happens, as it frequently does when several of the pointers are near zero, reference must be made to the next lower dial, which will verify whether the pointer has passed the zero mark or not. For instance, if the upper dials apparently record 110,000 kilowatt-hours, by examining the lower dials carefully it may be that the reading should be 109,900. Experience and proper judgment will indicate the correct reading to the observer.

Benson, Minn. F. J. D.

Gas vs. Steam Power.

EDITOR THE PRACTICAL ENGINEER:

Concerning the subject of gas power, I can say very little from my own experience, but for several years I have been studying and learning from the experience of others. The knowledge thus obtained has convinced me that the use of gas of various kinds is increasing, but the production of steam engines is also increasing.

In many plants, both large and small, the fact that heat is necessary, and that steam is the most economical medium for distributing it, is an important factor in the continued use of the steam engine, whether the exhaust or live steam is used, for heating.

It can be safely stated that the bulk of the power produced in this or any other country comes from the moderate-sized plant, and, as such plants use considerable heat, the engine, in many cases, acts principally as a reducing valve, in the case where low pressure steam is used; and where high-pressure steam is used a boiler would be necessary, anyway.

Of course, in the very largest power plants, conditions are different, and the possibilities of the gas engine being more economical, are greater, which has been proven by the successful operation of several large light and power concerns.

An argument often put forth by advocates of the gas engine is decreased cost of attendance, but it would require more evidence than has yet been produced to convince me of that. While in some cases the *quantity* of help may be less, the cost of the increased *quality* will be equal to that in a steam plant.

It has been proven that gas power costs less for fuel, but the space required for a complete producer plant about equals that for a steam plant of the same power. The first cost is greater for gas, and the question of repairs, I think, will be greater for a producer than for a boiler, and, while I cannot state positively from experience, I doubt if a gas plant can show as good a record for small expenditures as a steam plant.

In this city fully 90 per cent. of the manufacturing plants require heat in their process of manufacture, such as potteries, brick-yards, wood-working establishments, laundries, rubber mills, breweries, etc., all of which use all of the exhaust as well as live steam. My plant was remodeled about eight years ago. Suppose a gas-producer plant had been installed at the time instead of a steam plant. A 150 horse-power engine would have been required, and also a boiler for heating purposes. We have a heavy load to start, it being impractical to throw out some of the heavy machines which are needed all the time, and, besides, we heat one-third of the shops with exhaust steam.

I would suggest, however, that everyone study up on the gas engine and producer, as no one knows when one may be called to operate such a plant; but the man who says that the steam engine is ready to be "scrapped" will most likely meet the scrap-pile first. Be it gas or steam, the wise man will be

prepared. Knowledge is like a good gun; we never know when we will need it, but when we do, we need it mighty badly.

Trenton, N. J. H. H. Y.

EDITOR THE PRACTICAL ENGINEER:

My opinion on this subject is that steam engines and boilers will hold their own for some time to come, particularly in cold climates. The statement that steam will be out of existence inside of five years is absurd. Last week I paid a short visit to Gary, Ind., the "steel" town, which has grown from sand hills to a large commercial city within two years. As far as the writer is aware, there is not a high-pressure boiler in the whole town, except those which are used for construction work. The temporary pumping station is equipped with motor-driven centrifugal pumps, taking their current from the partly finished power house, where the prime movers are gas engines fed by the local gas works, until the mills are started, when blast-furnace gas will furnish all the power necessary, not only to drive the mills, but the whole town besides.

Let us look, however, at another case. A large department store in this city was running its own power plant, consisting of ten 60-inch by 18-foot and 20-foot boilers, direct-connected engines and generators, and a number of hydraulic and electric elevators. The exhaust from the different engines was generally sufficient to supply all the heat necessary during the seven months in the year that heat is required, except in very severe weather, when a little steam had to be added. A few years ago the local Edison Company was given the contract to supply light and power as far as the same was applicable electrically and the engines and generators were torn out. What was the result? The boilers have been run to their full capacity during seven months in the year to heat the building, and a majority of them the rest of the year to run the pumps, supply the hot water, etc. Engineers, firemen, steamfitters, plumbers, and repair men are as indispensable as ever. The size of the coal and repair bills are about the same; but the additional bill for "juice" every month is something enormous. This company will have its own power plant again in the near future, and the prime movers will not be gas engines, but the old reliable steam engine and boiler.

Gas engines and producers have made tremendous progress in the last few years, and the number of installations are rapidly increasing, but the steam engine and boiler has its place to fill, and any engineer will have to take good care of his health if he intends to live long enough to see the last engine and boiler consigned to the scrap pile.

Chicago, Ill. R. C.

EDITOR THE PRACTICAL ENGINEER:

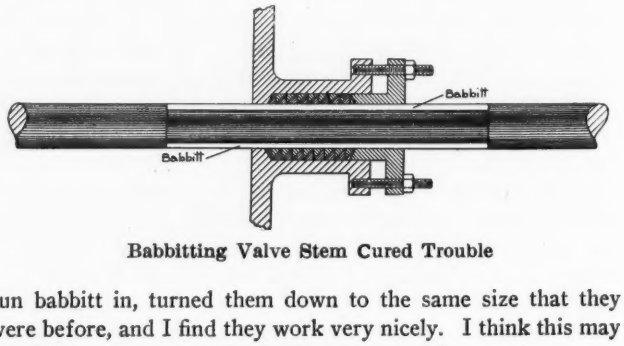
I read with interest H. H. F.'s article, and I must say that I myself lean a little in direction of the steam engine, although we will have to admit that the gas engine is making deep inroads in the steam engineering field. I have just visited a wrecked suction producer gas engine, which was rated at 85 horse-power and located in a local mill. One pillow block broke from the frame, causing a part of the crank to break, cracking four spokes in the fly-wheel and completely demolishing the frame of the engine. The engine was running at 208 revolutions, with no load, and had only been in operation eight months. Two weeks after it was erected it ran away and tore the driving belt into shoestrings. I doubt if there has ever been a steam plant as short-lived as this gas plant.

Whitewater, Wis. J. R. W.

Babbitted Valve Stem Cured Trouble.

EDITOR THE PRACTICAL ENGINEER:

On taking charge of this plant, which contains a 16 x 36 Corliss engine, I found, upon examining the valve stems, that they were scored badly. I took them out, turned off $\frac{1}{8}$ inch,



Babbitting Valve Stem Cured Trouble

run babbitt in, turned them down to the same size that they were before, and I find they work very nicely. I think this may be of help to someone else in the same trouble.

South Octon, Mass. H. J. C.

Duplex Pump Valves.

EDITOR THE PRACTICAL ENGINEER:

There has been some comment, recently, in these columns, about the reason why steam pump valves must have lost motion. In this connection it might be said that a steam pump is not altogether different in its workings from the steam engine, and in making the comparison, suppose that the fly-wheel was removed from the engine. The engine would make a half revolution and stop, owing to the lost effect of the fly-wheel to carry the engine over the dead center. Now, if the duplex pump had to make a full stroke of the piston, in order to do good work, and if all the slack were taken from the valves, it would be found that the valve would move too far compared with the movement of the piston. Now the pump workings may be changed by the distance the nuts are set from the valve, and in this connection it might be interesting to state my experience the past summer. I had two large pumps to overhaul, and to see that they were properly adjusted. The pumps were built and sent out from the factory to run on approximately 80 pounds of steam. When the plant grew larger, there were some compound engines put in, and new boilers were installed to carry 140 pounds pressure. The pumps in question were of the compound type, so they were being run condensing and it was only necessary to scarcely crack the throttle on the pump to pump against 80 pounds head. The valves were set to carry steam farther along the stroke than was necessary with the higher pressure, so the loose nuts were placed farther apart in order that the pump would cut off earlier in the stroke, and consequently use more expansion, and, with the throttle open, would work along nicely and on much less coal. The same adjustment was made on the low-pressure cylinder. The distance that the blocks or nuts were placed would depend

entirely upon the work the pump was doing and the amount of expansion you wished to use. All the expansion possible should be used to save steam. By setting the nuts farther from the valve, an early cut-off was given to the steam cylinder and more expansion was used.

The setting of a duplex steam pump valve is a simple thing when understood, but there are many who do not understand it. Many say throw the one piston to the extreme stroke and mark the rod next to the stuffing box gland; then reverse the operation and throw it to the other end and mark the rod. Repeat this for both sides, and when this is done, place the piston in the mid-stroke between the points; then set the valves exactly central over the ports or valve seat, and have the nuts the same distance on both sides and the pump will be ready to run. Now I have found in practice that if the crank lever is placed in a vertical position and the valve is placed central on its seat, and the nuts that carry the valve are an equal distance from the valve, it will work out all right, and will be shorter than the usual method.

Every time a pump kicks, it is not necessary to look into the steam end. Nine times out of ten, the trouble will be found in the water end. A poor fitting valve will cause the pump to knock on the discharge or suction. When the valves are tight and the plungers are in good condition, the pump will run quietly and do nice work, and when the pump commences to kick, you will know that the valves are leaking or the plungers need packing.

Drop in Pressure not Due to Separator.

EDITOR THE PRACTICAL ENGINEER:

The answer of E. S. H. to F. L. T.'s question on the efficiency of separators does not look good to me all the way through. After looking over his sketch, I wonder if he took into consideration the weight of water on the gauge connected to the boiler main. It looks as if it was ten or twelve feet below the main which would mean that the gauge would record about five pounds more pressure than the main, as every 2 1-3 feet of water is equal to one pound pressure. The drop in pressure from the main to the separator is usually 2 or 3 pounds; also his gauges might show a difference of 5 or 6 pounds when connected up side by side, all of which would account for the difference in pressure. Separators are usually built large enough so as not to lower the steam pressure more than a pound or so.

Lisbon, O. F. E. A.

Sawdust and Chips Reduced Power Required to Drive Fan.

EDITOR THE PRACTICAL ENGINEER:

The writer made several electrical tests on different machinery, among which were several planing-mill fans. I used a variable-speed interpole motor, with field regulation, so that I was able to get any speed between 300 and 1000 R. P. M. on the motor. This made it possible to belt direct from the motor to the different fans. By doing this I was able to get the actual horse-power consumed by each fan. The instrument that I used for taking the readings was a combination ammeter and voltmeter. By taking all of these readings I was able to get the watts input and the C^2R losses and the core losses. When the C^2R losses and the core losses were added together and subtracted from the watts input, the difference was the watts output, or the actual power consumed by the different fans.

As I knew that different planing mill men were anxious to know if the fan required more power drawing sawdust and chips than it did when drawing air only, I was able to determine when the fan required the greatest power. I was very much surprised to find that when a fan was drawing air only that it required more power than it it did when drawing sawdust and chips. I discovered that just as soon as the fan began to get sawdust and chips the power dropped off. The following is a test of a 70-in double fan drawing sawdust and chips:

	Interpole.	*Non-interpole.*
Diameter of commutator	135 in.	187 in.
Diameter of armature	190 in.	260 in.
Diameter of field frame	280 in.	351 in.
Number of poles	26	36
Av. volts per segment at 600	13.64	13.64
Weight armature and commutator	77,500 lbs.	143,700 lbs.
Total weight	248,500 lbs.	333,200 lbs.
Weight per Kw	92 lbs.	123.5 lbs.
Speed	90 RPM	75 RPM
Overall length along shaft	66½ in.	59⅜ in.
Overall width across feet	288 in.	351 in.
Overall height	281¼ in.	353½ in.

Speed of fan 820 R. P. M. required 23 8/10 H. P.
Speed of fan 823 R. P. M. required 24 1/10 H. P.
Speed of fan 830 R. P. M. required 26 6/10 H. P.
Speed of fan 848 R. P. M. required 30 6/10 H. P.
Speed of fan 735 R. P. M. required 16 3/10 H. P.
Speed of fan 683 R. P. M. required 11 3/10 H. P.

FAN DRAWING AIR ONLY.

Speed of fan 811 revolutions required 26 1/10 H. P.
Speed of fan 826 revolutions required 29 H. P.
Speed of fan 774 revolutions required 26 6/10 H. P.

You will notice that when the fan was drawing air only, at 826 R. P. M., it required 29 horse-power, and when the fan was drawing sawdust and chips, at 830 R. P. M., it required only 26 6-10 horse-power. You will also notice that when the fan was drawing sawdust and chips, at 834 revolutions, it required 24 7-10 horse-power, or 9-10 horse-power per one revolution of the fan. The speed of the fan was taken by a portable tachometer.

The next test on the fan was on a 30-inch single. When this fan was drawing air only, at 2168 R. P. M., it required 6 2-10 horse-power, and when the fan was drawing sawdust and chips from a double surface and sawdust from a band resaw it required 5 7-10 horse-power. Then I had two men bring a lot of chips from the planer, in addition to the sawdust from the resaw and the chips from the double surfacer, and I had them sweep these chips into the sweeping spouts on the floor, which reduced the horse-power of this fan, running at the same speed, to 4 8-10 horse-power. I also made a test on a 50-inch double fan, at 1560 R. P. M.; it required 54 8-10 horse-power, and at 1495 R. P. M. it required 41 2-10 horse-power. You will notice that the power increased very rapidly after the fan reached a certain speed. There was a difference of 65 R. P. M. at the fan, and the difference in horse-power is 13 6-10.

The above may be very interesting to some of your readers.

Two Rivers, Wis. J. H.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Shearing Strength of Rivets.

EDITOR THE PRACTICAL ENGINEER:

What is the strength of rivets used when making calculations for the efficiency of a riveted joint?

Detroit, Mich. M. R. T.

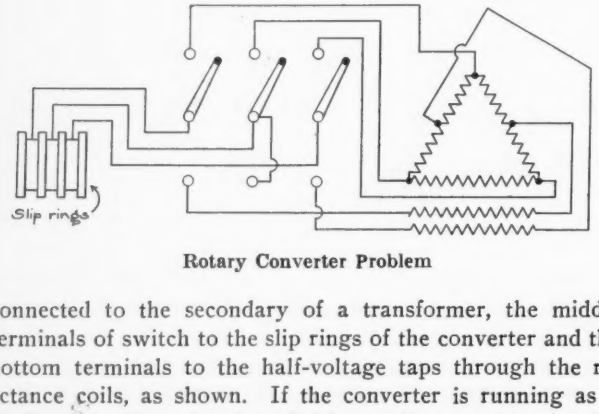
The maximum shearing strength of iron and steel rivets per square inch of cross-sectional area may be taken as follows:

Iron rivets in single shear.....	38,000 lbs.
Iron rivets in double shear.....	70,000 lbs.
Steel rivets in single shear.....	42,000 lbs.
Steel rivets in double shear....	78,000 lbs.

Electrical Questions from New South Wales.

EDITOR THE PRACTICAL ENGINEER:

1. The acompanying diagram represents the wiring of a converter. The top terminals of the two-throw switch are



Rotary Converter Problem

connected to the secondary of a transformer, the middle terminals of switch to the slip rings of the converter and the bottom terminals to the half-voltage taps through the reactance coils, as shown. If the converter is running as a D. C. motor (from bus-bars fed by another converter) prior to synchronizing, the oil switch connecting the primary to the high-tension bus-bars being closed, what would happen if the switch should fall into the bottom terminals, the three blades of the switch being connected together by an insulating bar?

2. When two or more converters are working in parallel, the field discharge switch of one is thrown over to the "off" position, leaving the converter connected to both the D. C. and the A. C. bus-bars, what effect will this have (1) on the machines so treated, and (2) on the machines still running normally?

3. When a generator (shunt or compound) is supplying current to a circuit and the shunt circuit becomes open-circuited, as in the case of one of the leads breaking, what would be the effect? In the case of a rotary converter, if the same thing happened, what would be the result?

4. Two or more three-phase rotary converters are working in parallel and while so working one of the phases of one of the converters becomes open-circuited. What will be the effect; or when synchronizing one of the converters, only two of the three switches on the A. C. side are closed, what will be the effect?

5. In a three-phase system, if one of the three mains should become earthed, what will happen; or if a person should come in contact with one of the bus-bars, will a shock result?

Sydney, New South Wales. W. F.

1. If the switch should fall into the position of half-voltage taps when the rotary converter was at full potential and the transformer was at half potential and both in phase, there would be a considerable flow of current on the direct-current side of the rotary. The amount of this current would depend upon the difference of potential and the capacity of the system, and which may in some cases be very serious to the transformer winding. If this switch should fall into contact with the phase just opposite to each other the result would be similar to a short circuit on both the A. C. and D. C. side of the rotary.

2. When two or more converters are operating in parallel and the field of one should be broken, the rotary with the open field would cause a short circuit on the D. C. bus, which would also be the case on the A. C. system. If the D. C. breaker should open, the rotary would continue to run, taking full load current from the A. C. side. If the A. C. circuit breaker would open and the D. C. breaker remain closed, a short circuit would remain on the system.

3. In case the shunt field opening in a D. C. generator, the machine would lose its field magnetism and the electro-motive force would die out. In case the shunt field of a rotary converter opened, short circuits would result on both the A. C. and D. C. side.

4. When two or more three-phase rotary converters are working in parallel and one phase of the rotary becomes opened, there would be no effect upon the operation of the rotaries. If the rotary was loaded, the D. C. load would fall off slightly and the load would be carried by the other two phases.

5. If one phase of the low-tension side of the rotary becomes earthed, it would raise the potential to ground. Shock may be experienced from either the D. C. or from the A. C. side of the rotary, the amount depending upon the potential.

Required Tensile Strength for a Given Diameter and Thickness of Boiler. Size Pump for a Given Capacity.

EDITOR THE PRACTICAL ENGINEER:

Please answer the following questions in your next issue:

1. What tensile strength must the material have for a boiler with an inside diameter of 56 inches, thickness of shell ¼ inch, single-riveted joint, to bear a pressure of 180 pounds per square inch safely?

2. Of what dimensions must the water end of a single-acting pump be to deliver 800 gallons of water per hour,

running at 100 feet of piston travel per minute?

3. What type of engines are called cross-compound engines, and why are they so called?

New Philadelphia, O. V. M. R.

1. A formula for finding the tensile strength required of a single-riveted boiler is as follows:

$$T = \frac{P \times D \times F}{2\,B\,t}$$

where T = Tensile strength of plate.
P = Pressure in pounds per square inch.
D = Diameter of boiler in inches.
F = Factor of safety.
B = Percentage of strength of joint.
t = Thickness of plate in inches.

Substituting the given values in the formula, the tensile strength of the plate should be

$$T = \frac{180 \times 56 \times 5}{2 \times .70 \times .25} = 144{,}000 \text{ pounds per square inch}$$

which shows that not only is the boiler pressure too high for that type of boiler, but that the shell is too thin for the given diameter.

2. As there are 231 cubic inches in one gallon, 800 × 231 = 184,800 cubic inches represents the volume swept through by the piston in one hour, or 3080 cubic inches per minute. The speed of piston being 100 feet per minute, or 1200 inches, the area of piston should be 3080 ÷ 1200 = 2.56 square inches, if double-acting or 5.1 square inches, if single-acting. Allowing for, say, 70 per cent. efficiency, gives 7¼ inches as the area of the cylinder, or about 3 inches diameter. Since the speed of the piston is 100 feet per minute, and assuming that it makes about 150 strokes per minute, the length of the stroke should be 5 inches, so that a 3-inch x 5-inch pump should fulfill the requirements.

3. An engine in which the flywheel is placed so as to revolve in the plane between the two cylinders, so that the steam from the high-pressure cylinder has to cross the space left by the flywheel, is called a cross-compound engine.

Cameron Pump Valve Motion.

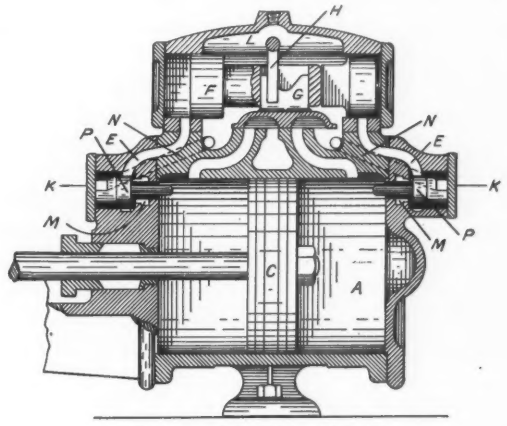
EDITOR THE PRACTICAL ENGINEER:

Will you please explain to me the operation of the valves on a Cameron pump? I do not exactly understand the valve motion.

Denver, Col. E. R. S.

Referring to the accompanying section of a Cameron pump, it will be seen that A is the steam cylinder, C the piston, L the steam chest, F the chest plunger, the right-hand end of which is shown in section; G the slide valve, H a lever for reversing the steam-chest plunger F by hand when found necessary, P P are the reversing valves, K K are the reversing valve bonnets, and E E are exhaust ports leading from the ends of the steam chest direct to the main exhaust by means of passage M M, and which are closed by the reversing valves P P.

The operation of the pump is as follows: The piston C is driven by steam admitted under the slide valve G, which, as it is shifted backwards and forwards alternately, connects opposite ends of the cylinder A with the live steam pipe and the exhaust. This slide valve G is shifted by the auxiliary plunger F. The hollow ends of F are filled with steam, and this, issuing through a hole in each end, fills the spaces between it and the heads of the steam chest in which it works. Pressure being equal at each end, the plunger F, under ordinary conditions, is balanced and motionless; but when the main piston C has traveled far enough to the left to strike and open the reversing valve P, the steam exhausts through the port E from behind that end of the plunger, which immediately shifts accordingly and carries with it the slide valve G, thus reversing the pump.



Section of Cameron Pump

No matter how fast or slow the piston is traveling, it must instantly reverse on touching the valve P. As will be noticed, the plunger F acts as a slide valve to close the port E and is cushioned by the steam confined between the ports and steam-chest cover. The reversing valves, P P, are closed as soon as the piston C leaves them on the return stroke, there always being a constant pressure of steam behind them, which is led to them from the steam chest by the ports N N shown by the dotted lines.

Increasing Steaming Capacity.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly advise through your query column the following:

We have three boilers in our mill, 60-inch x 16-foot tubular, in separate furnaces, fed by injectors, fired with sawdust (yellow pine), connected with steam, to steam two engines 16 inches x 24 inches and 14 inches x 18 inches, both pretty well loaded, safety valves set at 100 pounds; but we are never able to hold the steam up to that amount.

We have never used an indicator on the engines, but we know the valves are square, and no steam leaks. The boilers also supply steam for a 9-inch x 40-foot shotgun steam feed, and steam nigger with two cylinders 8 inches and 10 inches, respectively.

Can you suggest any changes that would increase the steaming capacity of the boilers, and how much would be gained by putting all three boilers in a battery?

Timber, Texas. G. O. B.

According to the dimensions of the boilers, they have a rated capacity of 65 horse-power each, or 195 H. P. for the three. Allowing an evaporation of 30 pounds of water per

horse-power per hour, the boilers should be capable of supplying 5850 pounds of steam to the engines. If the engines are using more steam than this, the boilers are overloaded. The steam consumption on the engines, if they are of the cut-off type, may be somewhat decreased by raising the boiler pressure, if that is permissible, or the steam supply may be somewhat increased by increasing the draft so as to burn more fuel.

The maximum horse-power of a boiler can only be obtained by keeping the heating surfaces clean, and means should be taken to attain that end if they are not clean. The feed water should also be heated before admission to the boiler. If a feed-water heater is not used, it would be advisable to install one, as the steaming capacity of a boiler is considerably increased by introducing the feed water into the boiler at a temperature as near 212 degrees as possible. If, however, the boilers are overloaded, which can only be found out by measuring the amount of feed water fed to the boilers, by indicating all the engines or by measuring the amount of exhaust steam, then another boiler should be installed, as in any case a crowded boiler is not generally conducive to good economy. Putting the three boilers in a battery would probably help in keeping up steam, as two of the boilers could be forced while the third was being fired.

Thickness of Boiler Plate. Air for Combustion.

EDITOR THE PRACTICAL ENGINEER:

If I want to carry 135 pounds steam pressure on boiler 63 inches in diameter, efficiency of joint 76 per cent., how can I calculate what the thickness of plate should be?

If I want a fan for a battery of boilers aggregating 400 horse-power, how many cubic feet of air per minute must the fan deliver, assuming that a pound of coal requires about 230 cubic feet for its complete combustion and one pound of coal evaporates 8 pounds of water?

Dorchester, Mass. C. A. H.

The formula for finding the thickness of the boiler plate when the diameter, working pressure and efficiency of the joint are known is as follows:

$$t = \frac{P \times D \times F}{2 \times T \times B}$$

in which t = thickness, in inches.

D = diameter of boiler in inches.

P = working pressure, lbs. per sq. in.

B = percentage of strength of joint.

T = tensile strength of material.

F = factor of safety.

Allowing a tensile strength of 60,000 pounds per square inch and a factor of safety of 5, the formula becomes

$$t = \frac{135 \times 63 \times 5}{2 \times 60{,}000 \times .76} = .466''$$

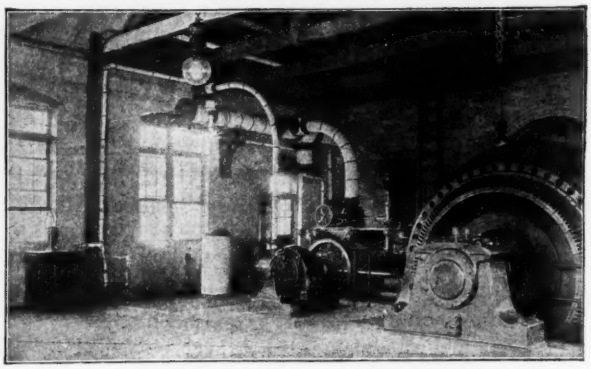
so that the thickness of the plate should be ½".

Since the evaporation of about 30 pounds of water per hour under the usual conditions, is equivalent to one horse-power, the 400 horse-power is equivalent to the evaporation of 12,000 pounds of water per hour, and since 8 pounds of water are evaporated per pound of coal, 1500 pounds of coal are used per hour, or 25 pounds per minute. As it requires 230 cubic feet of air to burn one pound of coal, the fan used to supply the boilers with air must handle 230 × 25 = 5750 cubic feet of air.

The "White Star" Oiling System in Modern Power Plants.

The idea is not uncommon that power-plant practice in the mining regions is usually of a low grade; that rough buildings and rough equipment are generally considered sufficiently good for service in this rough work. While there are many mining plants of such character as to offer ample excuse for this idea, it is a fact, nevertheless, that many modern power plants of most excellent sort are installed by mining companies who have large projects to work out.

Down in what most people regard as the wildest part of south central West Virginia, in the territory from which some of our finest smokeless fuels are secured, is the McKell Coal and Coke Company, Glen Jean, W. Va., operating collieries scattered at convenient points over a tract of several thousand acres. Electric power for operating these numerous scattered mines is supplied by an alternating current system of distribution from a central power plant. High-tension alternating current is transmitted from the central station to scattered sub-stations, where it is transformed and converted into low-tension continuous current for use at the adjacent mines.



The "White Star" Oiling System in the Plant of the McKell Coal & Coke Co., Glen Jean, W. Va.

The illustration shows the first 500-kilowatt alternating current generating unit in the power house, which provides space for installation of a duplicate unit. At the left may be seen the Duplex type White Star oil filter and circulating pump of the White Star continuous oiling system here in use for lubricating all the engine bearings. Overhead, out of sight among the roof trusses, is a reservoir, from which the oil is piped to feeds fitted to all the bearings on the engine. All oily drips from the various bearings are drained to a tank beneath the engine-room floor. After being thoroughly cleaned in the filter, the oil is pumped back to the overhead reservoir, ready for use again. Thus there is a constant stream of oil fed to all bearings, amounting in this case to a circulation of about 200 gallons per day. The reservoir is so arranged that any excess pumped from it would be returned through automatic valves to the filter.

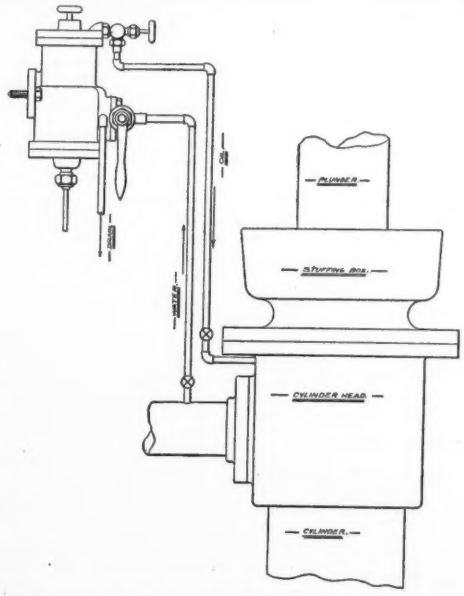
By use of the White Star continuous oiling system the bearings are all supplied with a copious flood of oil, affording that generous supply which is known to be necessary to perfect lubrication, yet without waste, since not a drop of oil can escape

from the system, except as it is actually worn out in the bearings.

The White Star filter and the White Star continuous oiling system are made and furnished by the Pittsburg Gage and Supply Company, Pittsburg, Pa.

Keystone Automatic Pressure Feed Lubricator.

Every engineer having plunger elevators in his charge is familiar with the difficulties attending their maintenance in a working condition, on account of leaky plunger packing and the great care which must be exercised to prevent excessive



Keystone Automatic Pressure Lubricator for Cylinder Elevator

abrasion and scoring or grooving of the plunger. The importance of providing means for proper lubrication of the wearing surfaces to prevent rapid destructive wear, appears, however, to have been entirely ignored up until recently, when the Keystone Elevator Inspection and Repair Co., Mutual Life Bldg., Philadelphia, Pa., after many years of experience in the repair of all types of elevators, have placed upon the market the Keystone Automatic Pressure Feed Lubricator, a sketch of which is shown in the accompanying illustration.

It will be noticed by reference to the diagram that the lubricating medium is introduced directly under the piston packing and is brought into direct contact with the wearing surfaces by means of pressure. The lubricant is also forced by the pressure within the cylinder and because the oil floats on the top of the water, it thoroughly permeates the plunger packing, from which it will, as a natural consequence, form a film on the surface of the plunger the entire depth of the stuffing box at the most opportune time when the plunger is in ascent of its motion, thus producing a condition mechanical lubrication, thereby effecting a saving in the use of packings and in the consumption of lubricating material.

The exact quantity of lubricant required for lubrication of the plunger can be readily ascertained and the adjustments necessary to regulate the flow are exceedingly simple. It can be located in any convenient position adjacent to the elevator hatchway which is a particular advantage as it is not necessary to interrupt the elevator service in order to refill the lubricator. The use of a lubricator of this type obviates the difficulty of having to enter the elevator pit, and slushing the plunger by hand is entirely eliminated.

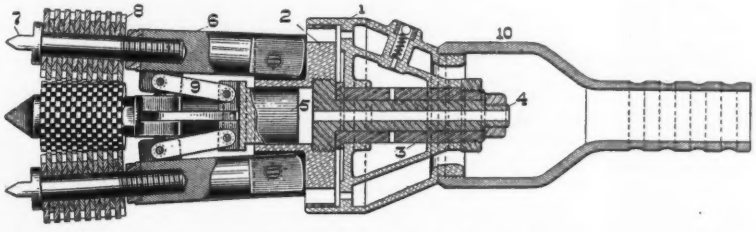
The lubricator has had extensive use on plunger elevators and it has been found without exception that when the lubricator has been installed where the plunger was reasonably smooth and of uniform diameter, the plunger can be maintained without difficulty in good working condition an indefinite length of time.

The "Rapid" Turbine Tube Cleaner.

The accompanying illustration is a sectional view of the "Rapid" Turbine Tube Cleaner, which is designed for use in all types of water-tube boilers, and which can be operated by either water, steam or air, as found most convenient.

The cleaner is simple in construction; all the parts may be readily replaced, and the only precaution necesary in its operation is to keep it properly lubricated. The scale is removed by forcing the cutters firmly against it with sufficient power to revolve the cutters, which, however, cannot spread beyond the inside diameter of the tube.

The operation of the turbine is as follows: The same pressure that revolves the turbine, *2*, acts on the piston, *5*, through a hollow bushing, *4*, which is screwed into the turbine and keyed. This pressure forces out the arms, *6*, against the boiler tube, the links, *9*, connecting the arms and the piston. The cutters, *8*, are held in place by hardened steel studs, *7*, which can be adjusted so that the cutters cannot spread beyond the given diameter of tube. By removing the nut, *4*, at the end of the bushing the cleaner can be taken apart and cleaned.



Sectional View of the "Rapid" Turbine Tube Cleaner

The "Rapid" turbine tube cleaner is designed to remove scale from all types of water-tube boilers in a very rapid manner, the makers claiming that it takes from 33½ per cent. to 50 per cent, less time to clean tubes when this type of cleaner is used. Special designs of cleaners are furnished for boilers having curved tubes. The Thomas Andrews Manufacturing Company, of Rockaway, N. J., are the manufacturers.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

Edwin H. Ludeman & Co., No. 42 Broadway, New York City, N. Y., have arranged for the eastern agency of the Detroit Stokers manufactured by the Detroit Stoker & Foundry Co., of Detroit, Michigan. These stokers have been installed for service in connection with all the leading makes of boilers, and are said to have given general satisfaction wherever used.

A catalogue of Nason Steam Traps may be had by writing to the Nason Mfg. Co., No. 71 Fulton Street, New York City. However, these traps are so well-known and have been so widely used, that many engineers can order them without a catalogue. Their simplicity of construction and freedom from annoyances that beset some other types of steam traps, have made them popular wherever used.

The Riverside Engine Co., of Oil City, Penna., are getting out a complete line of gas engines to be operated on any of the power gases, and are building some other large sizes. A catalogue showing some of their large engines will be of interest to any engineer interested in the subject of gas engines for power purposes. A copy of this catalogue will be mailed upon request.

Will a gas engine drive an electric generator and give steady light? This question has been so frequently asked that the Weber Gas Engine Co., of Kansas City, have issued a brochure which proves that this is possible, at least with the Weber Engine. A copy of the brochure may be had upon request.

The Salamander Grate Bar Co., Liberty, Corner of Greenwich, New York City, issue a catalogue that shows the Salamander Dumping Grate, the Aetna Shaking Grate and also other styles of shaking Grates manufactured by their Company. A copy of this catalogue may be had upon request.

Keystone Elevator Inspection & Repair Co., Mutual Life Building, Philadelphia, Pa., have opened a branch at 803 Atlantic Avenue, Atlantic City, N. J., where they are prepared to make all kinds of elevator and machinery repairs on the shortest possible notice. The success of this Company in Philadelphia, where they do practically all of the elevator repair work, is an indication that they will be highly successful at their new branch shops. Mr. Jno. M. Maloney is in charge of the Atlantic City branch.

The National Pipe Bending Co., 157 Lloyd Street, New Haven, Conn., issue a catalogue describing their Feed Water Heaters, which every engineer should have. It contains just the sort of information that an engineer needs when purchasing a heater, such as the sizes, capacities, prices, etc. A copy of this interesting little catalogue will be mailed upon request to any engineer who is in the market for a heater.

"Packing Tools" are an engine room necessity. The days for handling packing with an ax and crow bar are over. Every engineer should have a set of good packing tools. These may be procured, at small cost, from the Mound Tool & Scraper Co., of St. Louis, Mo. A catalogue describing a set of these tools will be sent to any reader mentioning this paper.

"GRAPHOIL" Lubricating Specialities, for lubricating steam cylinders with a combination of oil and graphite, are described in an excellent little catalogue just issued by the Graphoil Lubricator Co., 51 Clymer St., Brooklyn, N. Y. By the use of these lubricators, it is possible to use graphite in connection with oil without any of the objectionable features that sometimes rise through the use of graphite, when fed through the ordinary type of lubricator.

Another new pamphlet has been issued by the "S-C" Regulator Co., Fostoria, Ohio. It is devoted to a description of the "S-C" Regulator for controlling the water level in steam boilers, and the "S-C" Pump Governor, which latter has no valves, floates, expansion tubes, exhaust, packing joint or pistons, and which is in effect a governor without a working part.

The Murray Iron Works Co., Burlington, Iowa, have issued a magnificnet new catalogue describing the Murray Water Tube Boilers, which will be of more than ordinary interest to any prospective purchaser of new boilers for power purposes. Those who write for a copy of this new catalogue should ask for Catalogue No. 60.

Pipe Cutting and Threading Machinery and Tools of every kind, are shown in a fine, large catalogue issued by Curtis & Curtis, of Bridgeport, Conn. Inasmuch as all engineers require this class of tools and machinery to a greater or less extent, the Curtis & Curtis Co., will be glad to send a copy of their catalogue to any engineer upon request.

"The Wisconsin Engine Company, of Corliss, Wis., has received the resignation of Mr. Frank Engelhardt, who was in charge of the Chicago Sales Office of this Company. The Wisconsin Engine Company has decided to close the Chicago Office on March 1st, 1908, and for the time being to conduct the business from that district under the direct charge of Mr. C. T. Myers, General Sales Manager at Corliss."

The High Pressure Indicator, for gas engine work, built by the Trill Indicator Company, Corry, Pa., has some distinctive features that are worth looking into when purchasing an Indicator for this purpose. A booklet describing this Indicator will be sent to any engineer upon request.

The Cherry Chemical Company, manufacturers of the Red Seal Boil Compounds, is now permanently located in their new building, 1018 Callowhill Street, Philadelphia, Pa.

The carpenters, painters and plumbers have all completed their work. The Cherry Chemical Company has nothing to do now but fill orders.

They have stated to us that their business for the months of January and February, of 1908, was larger than their business for the same two months in 1907. This certainly speaks volumes for the Red Seal Boiler Compounds.

Wanted

NEW INDICATOR AND REDUCING MOTION, all complete, never used, very cheap, for cash. Fully guaranteed. Address Widow, No. 2557 Mole St., Philadelphia.

WANTED.—Thoroughly competent steam specialty salesman. One that can sell high grade goods. Address, M. M. Co., care of THE PRACTICAL ENGINEER.

"AN ENGINEER in each town to sell the best Rocking Grate for Steam Boilers. Write. MARTIN GRATE CO., 279 Dearborn St., Chicago."

We want a good Salesman in every city in the United States, to handle Ideal Metallic Packing. Manufacturers' Agents and Engineers, preferred.—Ideal Metallic Packing Co., South Stillwater, Minn.

WANTED—Engineers, Firemen, Electricians, Machinists, etc. New 25-page pamphlet containing questions asked by Examining Boards sent free upon request. Address, GEO. A. ZELLER BOOK CO., 4467 W. Belle Place, St. Louis, Mo. Established 1870.

WANTED.—Engineers and Mechanics to make big money selling Incomparable "Dozit" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. *Byram Co.*, 225 Congress Street, Boston, Mass.

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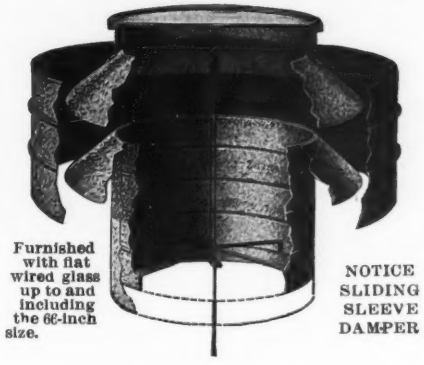

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The Morehead Trap is making more headway. Owing to the increasing demand for this trap from Canadian engineers and steam users, it was deemed best to manufacture the traps right in Canada, therefore, arrangements have been completed for the manufacture of Morehead Traps at Chatham. In the future, all Morehead Traps for Canadian customers will be sold F. O. B., Chatham, Ont.

J. A. & W. Bird Co., 34 India Street, Boston, Mass., have issued two text books on Power Transmission, which are the first of a series of six similar books. The series will treat on such features as quarter turn drives, shafting designs, miscellaneous notes on belting, etc., they will be very glad to send them, free, to any who write for them on business paper.

A practical demonstration of the virtues of "Albany Grease," of special interest to the engineer is furnished in a mailing card received from Messrs. Adam Cook's Sons, 313 West Street, New York City, the only makers of this ideal lubricant.

Every engineer having plunger elevators in his charge, is familiar with the difficulties attending their maintenance in a working condition, on account of leaky plunger packing and the great care which must be exercised to prevent excessive abrasion and scoring or grooving of the plunger, all of which is due to lack of provision for proper lubrication. Therefore, all engineers in charge of plunger elevators may profit by reading a new booklet which describes the Keystone Automatic Pressure Feed Lubricator; a new device of evident merit for automatically lubricating plungers which will not only increase the efficiency and greatly prolong the life of the packing, but will effect a big saving in lubricants. This booklet is issued by the Keystone Elevator Inspection & Repair Co., Mutual Life Bldg., Philadelphia.

The Jacobson Machine Mfg. Co., of Warren, Pa., have recently established a Southern office at Atlanta, Ga., at which point they will carry a full stock of the line of gas and gasoline engines, manufactured by that concern; also a stock of repair parts. This business will be in charge of Mr. C. R. Morrison, who has for sometime been traveling representative of this concern in the Southern States. The office and store-room is located at 676 Marietta Street, Atlanta, Ga.

This Company is one of the concerns engaged in the manufacturing of gas and gasoline engines that has not experienced any slack up in the orders received, nor volume of business done. The concern reports having laid off no men, nor reduced wages, since the panic started. Is running full capacity, with orders booked, at present, sufficient to keep the plant going full capacity for nearly two months. The Southern trade of this concern has been buiit up at a very rapid rate during the past year.

"The Wisconsin Engine Company, Corliss, Wis., manufacturers of Corliss Steam Engines, Gas Engines, Pumping Engines, Air and Gas Compressors, have established a branch office in Atlanta, Ga., with rooms and offices in the Candler Building. Mr. Julius M. Dashiell has been appointed Sales Manager."

"The American Water Softener Company announces that it has opened a filtration department, and solicits inquiries from those contemplating the installation of water filters of any capacity and an opportunity to quote prices on apparatus guaranteed to produce absolutely satisfactory results under all conditions. The filtration department is under the management of Mr. Geo. F. Hodkinson, for many years prominently identified with the filter industry, who has had extensive experience in installing filtration plants under all conditions to meet any requirement. The Company will gladly make, without charge, analyses, recommendations, sketches and estimates for either filtration or water softening plants for any who contemplate such installations. Its filter installations will be of the same high character and efficiency as its favorably known and extensively used water softening plants."

The Ohio Blower Co., Cleveland, Ohio, have just published an 80-page catalogue of steam specialties which should be in the hands of every engineer. In simple language, with illustrations taken from every day life, is explained the Helico-Centrifugal Principle, which is applied in the design of the "Swartwout" cast iron exhaust heads, steam and oil separators. Self-closing ventilators are also described and helpful tables given. As a product of the printer's art, this catalogue could hardly be excelled. It is well worth sending for.

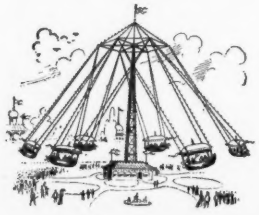
In the description of the Lardners' Point Pumping Station, Philadelphia, in the March issue, it was stated that each boiler was equipped with two American safety valves. This should have read that the twelve 200-horse-power Morris tubular boilers were equipped with American safety valves, and that the six 500-horse-power Edgemoor boilers were each equipped with Ashton improved type safety valves. The photograph of the water tube boilers on page 6, March issue, shows the Ashton valves equipped on the boilers of the magnificent pumping plant.

The Keystone Pressure Filter System is described in a handsome catalogue issued by the Keystone Chemical Company, Philadelphia, Pa. This filter is for the removal of all sediment, oils, etc., from the boiler-feed water A large number have been installed and in operation for a year or more with excellent results. They are especially efficient where a clean, pure water is desirable to protect products which come into contact with the steam. The catalogue in question is quite instructive, and will be appreciated by those having difficulties with bad feed water.

A Monarch Boiler Arch at the rear of your boiler will save lots of trouble and expense with the brickwork and will improve combustion and will increase the efficiency of the boiler. It is manufactured by the Mayville Specialty Company, Mayville, Wisconsin.

Engineers contemplating the purchase of new grates can procure an instructive circular describing the Cyclone Shaking and Dumping Grate from the Cyclone Grate Bar Company, 827 White Building, Buffalo, N. Y.

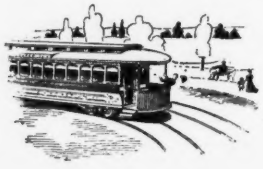
The development or application of The Helico-Centrifugal principle for separating water and oil from the steam with which it is entrained, is instructively described and simply, yet effectively, illustrated in a new and somewhat unique catalogue issued by the Ohio Blower Co., Cleveland, Ohio. Quoting from the catalogue in its explanation of the Helico-Centrifugal principle, as applied to the Swartwout separators and exhaust heads, manufac-



tured by the Ohio Blower Co., it says:

"Three of Nature's familiar laws combine to establish this principle, whereby entrained particles may be positively separated from steam. They are those relating to the inclined plane, the helix, and to centrifugal force.

"*The Inclined Plane.*—The mechanical feature of all apparatus designed upon this principle is the helix. Its first action, when inserted in the line of flow, is to gradually and almost



inappreciably deflect the steam from its direct line of motion. But the moment the steam is thus deflected from its direct path, it begins to follow a course corresponding to the surface of the helix. A combined motion results, the practically direct flow continues, but each particle also describes a circular arc. It moves in a spiral. The particles do not, however, continue to revolve at constant distance from the center.

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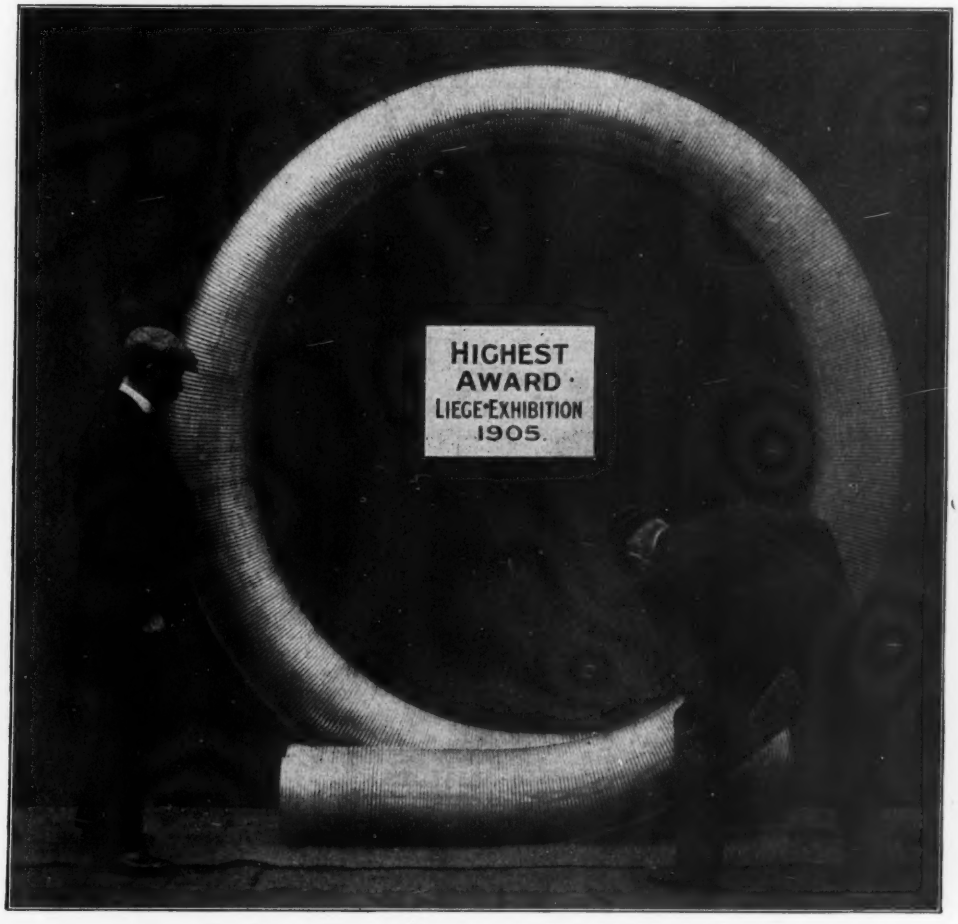

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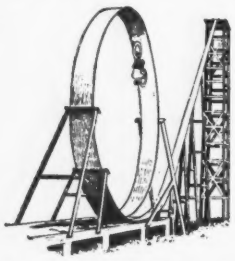
"That separation is inevitable, is due to the difference in weight of the steam and of the particles of oil and water. It is as inevitable as disaster to the automobile if it is not properly controlled while rounding a curve at break-neck speed.

"Centrifugal force is directly proportional



to the weights of the bodies in motion. As a consequence, in the case of an exhaust head, for instance, water which weighs about 1,600 times as much as exhaust steam, is thrown outward with 1,600 times the force. But this force is also proportional to the radius of revolution. The effect is cumulative, each particle, as the distance from the center increases, is impelled by the greater centrifugal force to move in a still larger circle until the limit set by the tube is reached. The condition is under the influence of centrifugal force, then becomes like that of the performer when he loops the loop."

There is much more in this interesting catalogue that is well-worth reading. Better write for a copy to The Ohio Blower Co., Cleveland, Ohio.

RECENT BOILER EXPLOSIONS AND POWER PLANT ACCIDENTS.

A boiler in a mill at Coulterville, Ill., exploded Feb. 29, seriously injuring the engineer, Leonard, Wies.

On March 2, a flywheel burst in a saw mill near Dalton, Ga., killing one man.

A boiler in the Lehigh University power house, Bethlehem, Pa., exploded on March 1, causing slight damage to the power house.

One man was killed by the explosion of a boiler on March 3, at West Albany, Md.

Collinwood, O.—Nearly one hundred and fifty children lost their lives, and over one hundred more were injured in an explosion and fire in Lake View school building, Collamer avenue, Collinwood, Ohio, caused by the explosion of a boiler.

On March 2, the explosion of a transformer at the plant of the Ellwood Power Co., Ellwood, Pa., threw flaming oil throughout the building, which was completely afire so quickly that the engineer, John Vorhees, did not even have time to shut off the turbine power. He escaped uninjured from the burning structure, which was almost totally destroyed.

One man was instantly killed by the bursting of a flywheel March 9, at Tremont, Mass.

A boiler at Lewis's mill, two miles south of Sheridan, Ark., exploded March 4, causing much damage.

On March 7, the power house of the Fairmont & Clarksburg Traction Company, Fairmont, W. Va., caught fire as the result of a short circuit. Loss, $50,000.

Two large boilers in the city water works at Gallipolis, Ohio, exploded March 11, wrecking the entire plant.

The municipal electric light plant at Tennile, Ga., was destroyed by fire March 3.

By the explosion of a boiler at 218 Dock St., Philadelphia, Pa., March 9, Adolph Leiper, the fireman, was seriously scalded. Daniel Krawson, the engineer, was also badly burned while extinguishing the fire in the boiler room and preventing the explosion of another boiler.

NEW POWER PLANTS AND IMPROVEMENTS.

Plans are being formulated for the purpose of installing a contemporary electric light plant at Taylor, Texas.

The United States government has granted a permit for the erection of a $1,000,000 power plant on the South Platte watershed, a short distance from Denver, Colo., and has also given a right-of-way for the necessary transmission lines. The plant will permit the production of 20,000 electrical horse-power.

The L. A. Dantzler Lumber Company of Moss Point, La., will shortly install a complete electric light plant in connection with its sawmills. The dynamos and auxiliary machinery have been ordered.

Herman Miller, architect has invited estimates on the power plant for the Medico-Chiurgical Hospital and College, Phila., Pa.

A building permit has recently been issued for a new $65,000 power plant which will be erected on Commerce and Holton Streets, Milwaukee, Wis., by the Continental Realty Company. The building will be of brick and 108 by 117 feet in dimensions.

Work has been started to provide the Manistee Light & Traction Co., Manistee, Mich., with a single power house to take the place of the old lighting station and the Vine Street power house which furnishes a current at present for the traction end of the business.

The City Council of Buena Vista, Col., has granted a 20-year franchise for a street light, heat and power plant to the Buena Vista Smelting & Refining Company. A condition of the franchise is that the Company shall expend about $5,000 in strengthening its power dam on the Arkansas River. Work will begin immediately and a solid masonry dam constructed.

The capacity of the St. Louis, Mo., municipal lighting plant is to be increased by the installation of a new 1000-kilowatt generator. Street lights for the entire West-side will be supplied from the municipal plant, and service will be furnished to homes.

Thomas Arnold of Brooklyn, S. C., has purchased 100 acres of land in the upper part of Spartanburg county, S. C., on which to erect an electric power plant.

The citizens of Escondido, Cal., will vote upon the proposition of installing an electric light plant. The Trustees are corresponding with supply companies for estimates.

Wartrace, Tenn., February 29.—A movement to establish an electric light plant at Wartrace, Tenn., has been put on foot, and $500 has been subscribed.

At a recent meeting of the Common Council of Little Falls, N. Y., a resolution was adopted directing the city engineer to report upon the availability of Spruce Creek water power for the purpose of erecting an electric light plant.

The City Council of Paterson, N. J., is consubmit the question of a $30,000 bond issue for an electric plant.

The City Council of Madisonville, Ohio, has decided to spend $10,000 in the rehabilitation of the municipal electric light plant.

The Des Moines Corn Milling Co., Des Moines, Ia., will build a new power plant. Officers of the Company are H. H. Polk, Jansen Haines, Geo. B. Hippee and Frank Kauffman.

The City Council of Patterson, N. J., is contemplating the issue of $1,000,000 worth of bonds, to be used in building an electric lighting plant.

The Southern Pacific Company has secured a power site on the Truckee River, near Sparks, Cal., and it will immediately begin the construction of an immense power plant. The Company now purchases its power from the Reno Power, Light and Water Company. The Southern Pacific Company will, in a few months, begin enlarging its shops at Sparks and will need more power, and for this reason intends to have its own plant.

The City Council of Mansfield, La., has authorized the sale of the municipal electric light plant.

At a recent meeting of the Duquesne Light Company, Pittsburg, Pa., plans for improvements on the corporation's lighting system costing $4.500,000 were considered. The plans provide for a large central power plant, to be located on the river front. George R. Webb is president.

The Nevada-California Power Company, of Goldfield, Nev., has awarded the contract for the equipment of a large power plant to the Westinghouse Co.

The initial capacity will be of a 4,000-horsepower. Two generating sets of 2,000-horsepower nominal output each will be installed.

The electrical energy is intended to be utilized for operating some of the leading mines in the Goldfield and Tonopah districts.

BOOKS FOR ENGINEERS

Mechanics Applied to Engineering. By John Goodman, Professor of Engineering at the University of Leeds (England). With 714 illustrations and numerous diagrams. 730 pages. $2.50.

Applied Mechanics. A Treatise for the use of Students who have time to Work Experimental, Numerical and Graphical Exercises Illustrating the Subject. By John Perry. 372 illustrations. 678 pages. $2.50.

Modern Steam Engineering in Theory and Practice. A Practical Work for Steam Users, Electricians, Firemen and Engineers. Over 200 questions with their answers likely to be asked by the examining boards are given, as well as 40 tables of the Properties of Steam for Power and Other Uses. By Gardiner D. Hiscox, M. E. With chapters on Electrical Engineering by Newton Harrison, E. E. Over 400 engravings. 487 pages. 8vo. $3.00.

Mechanical Engineering of Power Plants. By Frederic Remsen Hutton, Professor of M. E., Columbia University. 512 illustrations. 725 pages. $5.00.

LeVan—Practical Management of Engines and Boilers. Treating on Boiler Setting, Pumps, Injectors, Feed Water Heaters, Incrustation and Corrosion. Steam Engine Economy, Condensers, Indicators, Slide Valves, Safety Valves, Governors and Steam Gages, Lubrication, Belts and Pulley, etc. Including Compound and Mutiple Cylinder Engines and the Practical Management of Dynamos and Motors. 60 engravings. 337 pages. Pocket size. Leather bound. $2.00

Steam Boilers: Their Theory and Design. By H. DeB. Parsons, Consulting Engineer. 156 illustrations. 375 pages. 8vo. Net. Our price, $4.00

Roper—Engineers Handy-Book. Comprising Text, Formula, Tables and Questions on Power, its Generation, Transmission and Measurement; Heat, Fuel and Steam; the Steam Boiler, Accessories and an Explanation of Dynamos, Motors, Batteries, Switchboards, etc. Revised edition. Fully illustrated. 844 pages. Leather bound. $3.50. Our price, postpaid, $2.80.

Roper—Questions and Answers for Stationary and Marine Engineers and Electricians, with a chapter on what to do in Case of Accidents. Sixth edition. 306 pages. Leather bound. $2.00.

Kent—Mechanical Engineers' Pocket Book. A reference Book of Rules, Tablets, Data and Formulae for the Use of Engineers, Mechanics and Students. Revised and enlarged edition. 1129 pages; leather, $5.00.

Suplee—Mechanical Engineers' Reference Book. A Handy Book of Tables, Formulas and Methods for Engineers, Students and Draftsmen. By Henry Harrison Suplee. Third edition, revised and enlarged. 922 pages; leather. Net. $5.00.

Sutcliffe—Steam Power and Mill Work. Principles and Modern Practice. By George William Sutcliffe. 157 illustrations. 886 pages. Published at $4.50.

Hawkins' Hand Book of Calculations for Engineers. 330 pages. 150 illustrations. Comprising the elements of Arithmetic Mensuration, Geometry, Mechanical Philosophy, with copious notes, explanations and help rules useful to an engineer. $2.00.

Hawkins' Indicator. A practical treatise on the Steam Engine Indicator. Bound in cloth, with title and edges in gold. $1.00

Any of the above books will be sent post-paid on receipt of price.

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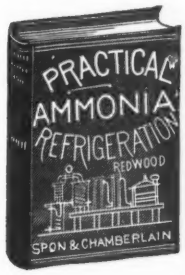

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THE PRACTICAL ENGINEER
46 N. 12th St., Philadelphia, Pa.

The citizens of Minnedosa, Man., Can., are considering the question of establishing an electric light plant in connection with the proposed municipal water works system.

The City Council of Nashville, Tenn., has granted the French Broad River Power Company a 45-year franchise to furnish electricity within the corporate limits of the city. The company proposes to erect a dam and hydro-electric plant at Pickle Island in the French Broad River for the purpose of generating electricity to be transmitted to Knoxville. Under the terms of the franchise, the plant must be in operation by March, 1912, and, upon the completion of the plant, pay the city $4,000 per annum for the first four years, and then $6,000 per annum until 1 per cent. of the gross earnings in the city amount to $6,000 per year, when the company is to pay the city 1 per cent. of its gross earnings in the city.

The City Council of Montreal, Que., Can., is considering the question of establishing a municipal electric light plant, to cost $182,000. John R. Barlow is city engineer.

A company has been organized in Childress, Tex., to establish a light and power plant in this place. For further information, address C. W. Mitchell.

James P. Harvey, of Ameca, Mexico, and associates are preparing to install a hydroelectric plant in that district to furnish electricity to operate the machinery of the mines and mills.

Plans are being made by the Memphis Ice & Electric Company of Memphis, Tex., to install an electric light plant.

Application has been made to the Commissioners of King County by Donald Fletcher, of Tacoma, Wash., far a franchise to erect transmission lines on the public road leading to Green River, Hot Springs. It is proposed to construct a large hydro-electric plant on the Cle Elum River about seven miles above the head of Lake Cle Elum. Applications have already been made for franchises in Pierce County.

It is reported that J. B. Wilbur, president of the Royal Trust Company, of Chicago, Ill., is interested in the construction of an electric light plant in Fort Worth, Tex.

The City Council of Wahoo, Neb., is considering the question of installing an electric light plant anl new water works for the city. An election will probably be held to vote on the proposition.

The Board of Trustees of Placerville, Cal., has taken further steps toward the installation of a municipal electric lighting plant. Two propositions are being considered, one on River Hill and the other from Smith's Flat. The board will proceed at once to procure the services of an engineer and obtain estimates relative to the matter.

The power house of the Atlantic Light & Power Company at Coeymans, N. Y., is rapidly nearing completion, the equipment of which consists of two 120-h. p. engines direct connected to alternating-current generators.

Plans are being prepared by Merrill H. Fisher for the construction of an electric power station at Alamagorda, N. M.

Plans are being made by the San Francisco, Vallejo & Napa Valley Railway Company, of Napa, Cal., to increase its service. It is proposed to purchase new cars and install new equipment in its power house, which will double the output of the plant.

The Two Republics Mining Company, of Jerome, Ariz., is making arrangements to install an electric plant in the early summer to provide electricity to operate the machinery for its mines. There is a water power on the property which will be utilized to generate electricity. Paul Smyly is secretary and treasurer of the company.

Plans for the buildings of the Pine Bluff Light & Water Company, Pine Bluff, Ark., have been completed by Ford, Bacon & Davis, of New York, N. Y., and contracts for the construction of the buildings will soon be let. A contract will also be let for the construction of a 3,000,000-gal. reservoir.

A. C. Musselman and D. A. Matheson, of Chico, have bonded the Richardson Springs property at Gridley, Cal., and propose to install a small power plant using the water from the second falls at that place.

Slocomb, Ala.—Plans are being considered for the construction of an electric light plant at Slocomb, Ala. A. C. Kelly is interested in the project.

OBITUARY

Mr. John L. McGiloray, a very popular salesman of the Peerless Rubber Mfg. Co., and one of the best known supply men in the steam engineering field, died at his home in Jersey City, on March 2nd, 1908, at the age of 48 years. Before connecting himself with the Peerless Rubber Mfg. Co., five years ago, he

was for 18 years connected with railroad work, and for 3 years with the Lambert Hoisting Engine Co.

He was a member of Bay View Lodge, No. 147, Jersey City, Damon Council, Royal Arcanum, National Association of Stationary Engineers, an honorary member of the Marine Engineers' Benevolent Association, and President of the National Exhibitors' Association.

To his many friends, his death came as a surprise, and his smiling countenance and his cheerful presence will be very much missed in the engineering field.

BOOK REVIEWS.

PRACTICAL ENGINEERING, by Carl S. Dow, Editor-in-Chief. Size, 7 x 10. Three volumes, 2250 pages. 2500 illustrations. Bound in half-Morocco. Published by the American Text Books Co., Philadelphia, Pa.

The field of mechanical engineering has become so large that it is impossible for one man to thoroughly understand every subject which comes within its scope, and it is also impossible in one small book to explain anything but one sub-division of the branches into which engineering is now divided. The above three volumes, however, aims to give the practical engineer the essence of all that is necessary in the study of mechanical engineering, and in order that each subject be thoroughly treated, twenty different engineers, each an expert in his line, have written different chapters in each book.

The Editor-in-Chief, is Carl S. Dow, formerly text-book writer, editor and instructor in the mechanical engineering of the American School of Correspondence. Some of the associate editors include such well-known writers as William L. Saunders, editor, *Compressed Air;* William R. Hulbert, managing editor, *Compressed Air;* Oscar C. Schmidt, editor THE PRACTICAL ENGINEER; Sydney G. Koon, editor *International Marine Engineering;* Milton W. Arrowood and H. H. Kelley, formerly associate editors *The Engineer;* Leon H. Rittenhouse, professor of engineering, Haverford College; F. Lowell Kennedy, assistant professor of machine design, Harvard University; Walter S. Leland, assistant professor Massachusetts Institute of Technology; George S. Hodgins, associate editor *Railway and Locomotive Engineering*, and W. H. Walseman, expert steam engineer.

Among the subjects treated are, the principles of mechanical engineering, types of boilers, boiler fittings, heat, fuels and combustion, draft, mechanical stokers and economizers, construction and design of boilers, setting and testing of boilers, pipe fitting, warming buildings, steam engine accessories, valves and valve gears, the steam engine indicator, types of engines, steam turbines, coal and ash conveyors, management and testing of steam engines, steam power plants, pumping machinery, hydraulics, hydraulic elevators, marine boilers and engines, crude oil as fuel, resistance of ships, locomotive engines and boilers, air brakes, compressed air, gas and oil engines, refrigeration, locomotive, marine and stationery engineering and practical electricity.

Each subject in the book is treated in a clear, practical way, and is well illustrated. It not only is a full exposition of the principles of the various subjects which it takes up, but it becomes a regular encyclopedia of information. It becomes at once a hand-book for the operating stationery engineer, a text-book for the student and a reference book for the consulting engineer.

Among the most meritorious chapters in the books are those relating to the construction and design of boilers and boiler shops and layout of plates, warming buildings, the chapters on governors and valve gears, pumping machinery, hydraulic elevators, compressed air and refrigerators.

Each subject in the book is treated from a different angle, so that the whole horizon of the filed of stationery engineering is visible to one looking through these books. It is stated that already 10,000 sets of these books have been sold, which is an indication of the favor which they have found with engines generally.